



THE GUY FOUNDATION

NEWSLETTER

September 2023

**Welcome to the 5th edition of The Guy Foundation Newsletter.
We hope you enjoy reading it, do get in touch with any
suggestions for future editions.**

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2023 AUTUMN SERIES AND THE SPACE HEALTH PROGRAMME

In our June Newsletter we were pleased to announce the launch of The Guy Foundation's Space Health Programme. After a successful [space health symposium](#) earlier this year, it is becoming clearer that there is an intersection between research of interest to the quantum biology community and important questions around the health of astronauts and the future of space travel. Quantum biology is primarily concerned with electromagnetic effects in biological systems, such as electron transfer or the effects of magnetic fields on biologically relevant chemical reactions. In space, the familiar electromagnetic environment in which all terrestrial life has evolved may be radically different. Quantum biology could help us understand how this new environment has an effect on biological systems, with our primary interest being the effects on the human body. While changes in gravitational forces have been investigated, research into the ways in which gravitational effects may interact with other environmental changes has been neglected to date.

This research could have a broad impact. It could shape space travel programmes, by taking into consideration how potentially harmful effects of the space environment can be potentially mitigated. Closer to home, space travel might serve as an excellent model for us to learn more about quantum effects in physiology, and in turn drive new therapeutics. Finally, due to the hold that space travel has on the popular imagination, this research could attract interest in the quantum biology field from the wider scientific community, public and funders alike.

To expand on the issues and questions raised so far in our discussions, The Guy Foundation's [2023 Autumn Series](#) of online

lectures will focus on space health. Lectures will range from the very practical perspective – a day in the life of an astronaut – to the open questions of theoretical physics – how might gravity be reconciled with quantum theory. For more details see the programme [here](#). If you have colleagues who would be interested in attending the live sessions, please ask them to contact Nina Copping n.copping@theguyfoundation.org, or they can keep up to date by subscribing to The Guy Foundation [YouTube channel](#) and requesting notifications when new talks are added.

Alongside the Autumn Series, we have been forming a working group to provide a pool of expertise for the Foundation team to draw on. A preliminary document outlining the issues and the research necessary to better understand the consequences of space travel for human health has been circulated to the working group. If you would be interested in joining the group, please contact Nina Copping n.copping@theguyfoundation.org.

2023 SPRING SERIES PROCEEDINGS

In the 2023 Spring Series, each of The Guy Foundation's funded teams presented results from their projects, which form part of the Foundation's collaborative [research programme](#) into aspects of quantum biology and bioenergetics. The talks and roundtable discussion have been written up in the Spring Series Proceedings, which has been circulated to our Faculty and will be posted to the website once the results have been published. Presentations by Rhys Mould, Mike Levin and Wayne Frasch are now available on our [website](#) and [YouTube channel](#), with the other presentations to follow as the research is made public.

NEW REVIEW PAPER BY THE FOUNDATION TEAM

The Guy Foundation's Director of Science Alistair Nunn had a paper published last month in the International Journal of Molecular Sciences entitled '**Informing the Cannabis Conjecture: From Life's Beginnings to Mitochondria, Membranes and the Electrome—A Review**', co-written with Geoffrey Guy and Jimmy Bell, available [here](#). Alistair has told us: "This paper represents over 15 years of thinking and writing, weaving together as it does a number of ideas and areas about how to explain why it is some compounds in cannabis, and other plants, seem to act as medicines. The key is to begin from the idea that life started based on the movement of charge through a membrane, possibly in an alkaline thermal vent, as a thermodynamic dissipative process leading to the self-organising structures we call life."

"This means that membrane fluidity, and the movement of charge, bioenergetics and oxidative stress are all intertwined, and that life has evolved to maintain this around a set point, in effect, a 'Goldilocks zone'. This might suggest that phenolic lipophilic compounds, such as cannabidiol, have evolved in the plant to manage stress by modulating this set point, which supports their emerging ability to modulate mitochondrial function. This explains why they can help restore homeostasis in some medical conditions, such as epilepsy. Humans, certainly in metabolic terms, share a great deal in common with plants. It also explains why these compounds can not only be anti-inflammatory, but also have anti-cancer and anti-pathogen actions." Whether the concept is right or wrong, Alistair hopes the paper will help scientists to think in a different way about this topic, as it has, until now, been dominated by a narrow pharmacological viewpoint. By his own admission he has made a number of assumptions, but if life did

originate from a quantum thermodynamic self-organising entropic impetus involving a flow of charge across a membrane, then, as the paper suggests, everything else seems to follow, including ageing and the importance of electric fields, and why modulation of membrane structure is so pivotal to everything. This approach might even support the concept that photonic homeostasis has a role in life. Thus this paper starts to bring together the many very basic threads that epitomise the thinking underlying the Foundation itself in its quest to enhance medicine, especially the polymath approach, as represented by the diverse 296 scientific papers and books cited in its text. A major point emphasised throughout the paper is that life is based on simple mechanisms, which today, still lie at the centre of some apparently very complex biochemistry; strip it back, and we begin to unlock what life is, and why it might go wrong, and potentially, how we might be able to correct it.

HOW TO MAKE QUANTUM + BIOLOGY WORK

The inaugural Gordon Research Conference in Quantum Biology, which took place earlier this year in Galveston, Texas, had a number of discussion sessions that focused on topics outside of the standard academic content. In one of these sessions, Louie Slocombe, a postdoctoral student from the University of Surrey, and the first student to graduate from the University's **Leverhulme Quantum Biology Doctoral Training Centre (DTC)**, presented a perspective on teaching and learning in quantum biology. While the presentation focused on the experience of being a student in the DTC, we thought some of the insights will resonate with the wider community's experience of the field of quantum biology. Among many other salient points – the different challenges faced by experimentalists as opposed to theoreticians for instance –

one thing seemed especially familiar. The strongly interdisciplinary nature of quantum biology, spanning physics, chemistry and biology, is often challenging, especially for those unaccustomed to the specific vocabulary – linguistic and mathematical – of these fields. But this interdisciplinarity is also its strength. As noted by Louie, one of the successes of the Leverhulme DTC is the peer-to-peer interactions, where students from different fields share knowledge. As we have seen demonstrated by the GRC and Big Quantum meetings, this sharing of knowledge and ideas irrespective of academic discipline is key in building the quantum biology community. It is certainly something The Guy Foundation aims to achieve with our own conferences and meetings, by providing a safe space where we can put aside any fears of appearing ignorant, help each other through any ‘vocabulary’ barriers and thus absorb as much knowledge and inspiration as possible from each other.

THE GUY FOUNDATION ONION PRIZE 2023



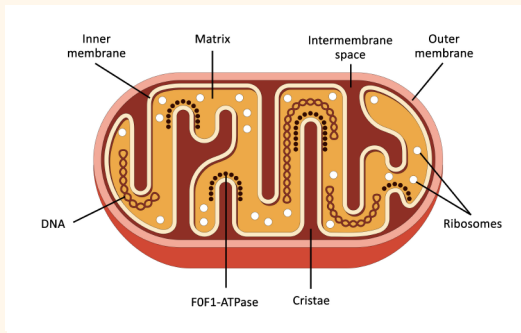
The deadline for entries to the The Guy Foundation Onion Prize competition, which is celebrating 100 years since Gurwitsch’s original experiment, is coming up soon: **Tuesday 26 September 2023**. Details on how to submit your entry are on our [website](#).

POPULAR QB RESOURCES

How do you engage people’s interest in quantum biology? It can be challenging to make it accessible for the lay person (and indeed some would argue, for many scientists too). We are thus collecting some [popular articles and talks](#) in a ‘Useful reading’ page on our website that we find helpful to refer to when talking to family and friends. We would be interested to hear from you with which popular resources you find particularly useful and we will add them to our website.

BOOKS & PAPERS

JOURNAL CLUB



Basic structure of a mitochondrion

For this issue's journal club, in light of the forthcoming Autumn Series, Alistair Nunn and Betony Adams have picked some thought-provoking papers reflecting the theme of space health, with a particular focus on mitochondria.

Many of us have heard of mitochondria being described as the 'power stations' of the cell. Growing research, however, suggests that they are involved in many other processes that are coupled to energy production, such as signalling. A recent paper adds a new angle on mitochondria. The paper '**Mitochondria in cone photoreceptors act as micro lenses to enhance photon delivery and confer directional sensitivity to light**' is in the journal *Science Advances*. Mitochondrial aggregates in mammalian photoreceptors have been hypothesised to be involved in the energetic demands of phototransduction. However, as the paper demonstrates, they also display optical properties, acting as lenses to focus the incoming light more efficiently. Even more interesting perhaps, is that these optical properties show some relationship to physiological or circadian state, at least in terms of the mammals employed in the study. Mitochondrial aggregates from active as opposed to hibernating animals were less effective at focusing light. The paper has a number of implications, not least for age or disease-related vision impairment.

Circadian rhythms are the focus of another recent paper, published in the journal *Aging Cell*. In the paper, '**Circadian regulation in aging: Implications for spaceflight and life on earth**', the authors review the evidence supporting their hypothesis that 'red-flag' health risks in astronauts during and after space travel might be explained by circadian dysregulation, in a similar manner to terrestrial ageing. They do this by comparing overlaps between the roles that the circadian clock plays in ageing and spaceflight with a focus on visual, cardiovascular, central nervous, and musculoskeletal systems. The authors conclude that it will be essential to understand exactly how circadian regulation is implicated in ageing, and to develop relevant interventions to improve health outcomes for both astronauts and the ageing population on Earth.

On the subject of circadian rhythms and space travel, there is some evidence that altered magnetic fields have an effect on circadian rhythms in fruit flies. This may be particularly interesting in light of a recent paper, '**Multi-system responses to altered gravity and spaceflight: Insights from *Drosophila melanogaster***' in the journal *Neuroscience and Biobehavioral Reviews*. *Drosophila melanogaster*, the fruit fly, is a well-established model organism for space biology studies. The paper's authors review advancements in gravitational biology, with particular focus on developmental, morphological, cellular, molecular, and neurobehavioral alterations in fruit flies, either directly through spaceflight or in simulated microgravity environments. What remains to be seen, however, is how these gravitational effects are consolidated or countered by other factors such as changing magnetic fields.

While positive, hypothesis-confirming results are often the aim of scientific experiments, negative results are as fundamental in

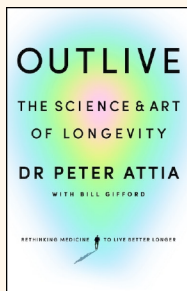
pushing a research field forward. As such, a recent paper published in *Nature*, '[No evidence for magnetic field effects on the behaviour of *Drosophila*](#)', serves as a useful counterpoint to the recent interest in radical pair mechanisms across a range of biological contexts. The paper finds evidence that magnetic fields affect the behaviour of fruit flies navigating mazes. The authors thus suggest that migratory birds should remain the organism of choice in the investigation of light-dependent magnetoreception. While this may seem a setback to expanding the context of biologically-relevant radical pair reactions, the paper focuses primarily on navigation, or the translation of spin chemistry into positional information. It remains to be seen what other biological functions, such as reactive oxygen species signalling, may or may not be magnetic field sensitive.

SPECIAL ISSUE REMINDER

A special research topic on Quantum-based Effects on Cell Physiology, guest edited by Margit Egg, Youngchan Kim, Jonathan Woodward and Robert Usselman is open for submissions on [Frontiers in Physiology Biophysics & Physics Biophysics](#). They welcome contributors to submit research articles, reviews, perspectives, or opinions for the following subject areas:

- Interaction of magnetic fields with cells, including weak or moderate magnetic fields, static and radio frequency fields
- Quantum processes in photosynthesis, vision, animal migration, enzymes, cell biology, olfactory sensing, and brain consciousness

Please note that the deadline for manuscript submission is **4 December 2023**.



Book corner

For this issue's book corner, Betony Adams has written a review of *Outlive: The Science and Art of Longevity*, by Peter Attia, published in March 2023.

OUTLIVE: THE SCIENCE AND ART OF LONGEVITY, BY PETER ATTIA

In a recent Guy Foundation meeting with flight surgeon and astronaut Tom Marshburn, the conversation turned to the subject of space health research as a microcosm for understanding terrestrial ageing. Tom mentioned that The Guy Foundation might be interested in Peter Attia's recent book, *Outlive: The Science and Art of Longevity*, which discusses the ways we might extend not just our lifespan, but also our healthspan. Many of the ideas expressed by Attia resonate strongly with The Guy Foundation's own interests in the metabolic underpinnings of ageing and the ways in which a better understanding of these metabolic processes might be leveraged to achieve compressed mortality.

The notion of compressed mortality is central to Attia's argument in the book. It is not enough to add extra decades to a human life, if those decades are spent in pain and illness. More importantly, we should aim at decreasing the years in which age renders us unable to enjoy life, not only adding years but adding worthwhile years. This is what Attia refers to as healthspan. In his opinion the practise of medicine needs a paradigm shift in how it frames health and disease. There have been two distinct eras in medical history, he argues: Medicine 1.0 which spans those centuries from the ancient world of Hippocrates until the advent of germ theory and the scientific method, and Medicine 2.0 which is still with us today.

Medicine 2.0 has made great strides in a number of contexts but despite these advances – and its success in treating acute disease – it has made, as the author puts it, scant progress against those diseases conventionally associated with old age. Attia refers to these as the Four Horsemen diseases: heart disease, cancer, neurodegenerative disease and type 2 diabetes and related metabolic dysfunction. In order to make progress against these diseases, he maintains we need a new way of thinking, a Medicine 3.0, which does not wait until the disease has manifested itself before intervention but rather practises proactive medicine, identifying risk factors years and even decades in advance and implementing a strategic response to these.

Outlive is an illuminating read on the agency we do have with respect to healthy ageing, despite our genetic lottery. Attia notes that, despite diabetes ranking behind the other Horsemen diseases as a leading cause of death, he believes it plays an underlying role in all of these diseases, which all show evidence of metabolic dysfunction. As we emerge from the acute phases of the COVID pandemic into a new era of chronic conditions such as long-COVID, a better understanding of how metabolism underpins, not only ageing, but disease in general, could see the consolidation of the era of Medicine 3.0.

CONFERENCES & MEETINGS

The Guy Foundation website now includes a page dedicated to quantum biology related conferences and meetings, both online and in person. For more information [see our website](#).

BIOEM 2023 OXFORD



From left to right: Katerina Cervinkova, Clarice Aiello and Michal Cifra at the BioEM Conference

June was a bumper month for quantum biology in the UK, with a number of familiar faces attending the second annual meeting of the new BioEM society in Oxford, from 18 – 23 June 2023. As noted on their website, **BioEM** is the world's largest and most significant bioelectromagnetics conference. Participants in the

conference are a diverse group, from both academia as well as industry. One of its stated aims is to identify gaps in science and as such we are glad to see quantum biology being represented.

QuEBS 2023

The annual **Quantum Effects in Biological Systems** (QuEBS) meeting took place from 26 – 30 June, 2023 at the University of Surrey, UK. The Guy Foundation's Alistair Nunn, Alasdair Mackenzie and Ifigeneia Kalampouka all attended. Ifigeneia kindly agreed to report back on the conference for us.

“ I was very happy to win the best poster award for my presentation of research that shows the effect of infrared light on senescence in cancer cells. In addition to this I found that engaging in direct discussions with esteemed scientists like cosmologist Paul Davies and molecular geneticist Johnjoe McFadden deepened my understanding of quantum biology and guided my research direction.

There were a number of interesting talks, such as the presentation by Nirosha Murugan, who has developed a 4D field application device which is small and portable enough to fit into the cell incubator. Through this device, living murine cells were exposed to interruption signals; 8-25 Herz for 15 minutes increased calcium influx and that resulted in decreased growth rate. She has also recorded biophotonic emission with a double dark-room-sensitive detector.

Lev Murokh’s presentation was also fascinating. Through biocrystallography, he was able to visualise the extracellular matrix of cells. Additionally he showed that cancer keratine cells from canines have distinct patterns of extracellular matrix. Mice cancer



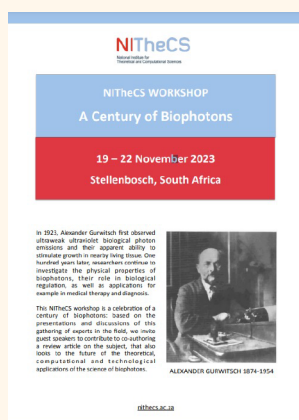
PhD student and Guy Foundation Team member Ifigeneia Kalampouka receiving her award for best poster presentation from Johnjoe McFadden

cells showed also distinct patterns, different from healthy mice. The patterns were different even before the mice were clinically ill, but later developed cancer. He suggested that the differences in biocrystallography patterns appear before cancer onset, and he proposed it as a biomarker in cancer. ”



The official group photograph of QuEBS 2023, at the University of Surrey

A CENTURY OF BIOPHOTONS CONFERENCE



As you may know, this year marks the centenary of Alexander Gurwitsch's first observation of non-chemical communications between onion roots, what has come to be known as biophotons. In celebration of this, Francesco Petruccione and Adriana Marais from Stellenbosch University are organising a focused writing workshop, A Century of Biophotons, to evaluate the current status and

future of biophoton research. The conference, which will take place in Stellenbosch, South Africa, from **19 – 22 November 2023**, hopes to replicate the success of a previous writing workshop organised by Francesco Petruccione: The future of quantum biology, which resulted in a [paper](#) of the same name. The conference is being hosted and funded by the **National Institute of Theoretical and Computational Sciences (NITheCS)** and we are delighted to say that The Guy Foundation has partnered with the event by donating £5,000 towards the conference costs. The programme and website will be shared on the [QB meetings page](#) as soon as it is finalised. We look forward to reporting back in the next edition of the Newsletter.

APS MARCH MEETING

The American Physical Society's annual March meeting is a cornerstone conference for physicists, attended by 13,000 researchers and students from across the world. Next year marks the 125th anniversary of the APS, and it seems fitting that this milestone also marks the first time that there will be a focus session dedicated to quantum biology, thanks to the continued efforts of Clarice Aiello. (Incidentally, Clarice wrote a [recent article](#) for the APS on why quantum biology needs to be taken seriously.) This session will be organised by Clarice Aiello and Christoph Simon, with assistance from Betony Adams. The in-person meeting will take place in Minneapolis in **March 2024**; for more details and important deadlines, see the [official website](#).

BIG QUANTUM MEETINGS

The Big Quantum weekly online meetings continue to be well attended. This seminar series is jointly organised by the Leverhulme Quantum Biology Doctoral College Training Centre (QB-DTC) and the Quantum Biology Tech (QuBiT) Lab at UCLA. The new programme which runs from **14 September 2023 to 29 February 2024**, is available [here](#). We have also listed the September – December sessions in '[Dates for your diary](#)' on page 17.

If you have conferences or meetings for us to include in the newsletter and on our website, please let us know.

DATES FOR YOUR DIARY



THE GUY FOUNDATION

**2023 AUTUMN SERIES ON QUANTUM BIOLOGY AND
SPACE HEALTH PROGRAMME**

Session 1: Wednesday 20 September

Day to day life of an astronaut and effects on healthDr Thomas H Marshburn, Sierra Space and retired NASA Flight Surgeon
and AstronautDr Scott M Smith, Human Health and Performance Directorate, NASA
Johnson Space Center

Session 2: Wednesday 4 October

Mitochondria and spaceProfessor Douglas C Wallace, The Children's Hospital of Philadelphia
(CHOP) Research InstituteDr Afshin Beheshti, Blue Marble Space Institute of Science
at NASA Ames Research

Session 3: Wednesday 18 October

Microgravity and radiation effectsProfessor Christopher D Porada, Wake Forest Institute
for Regenerative Medicine

Dr David Furman, Buck Institute for Research on Aging

Session 4: Wednesday 1 November

Potential effects of magnetic fieldsProfessor Jonathan Woodward, The University of Tokyo
Professor Wendy Beane, Western Michigan University

Session 5: Wednesday 15 November

Quantum gravity and inertial stresses

Professor Vlatko Vedral, University of Oxford

Session 6: Wednesday 29 November

Roundtable meeting**All sessions 15:00hrs – 17:00hrs UK-time on Zoom**Please contact n.copping@theguyfoundation.org to register

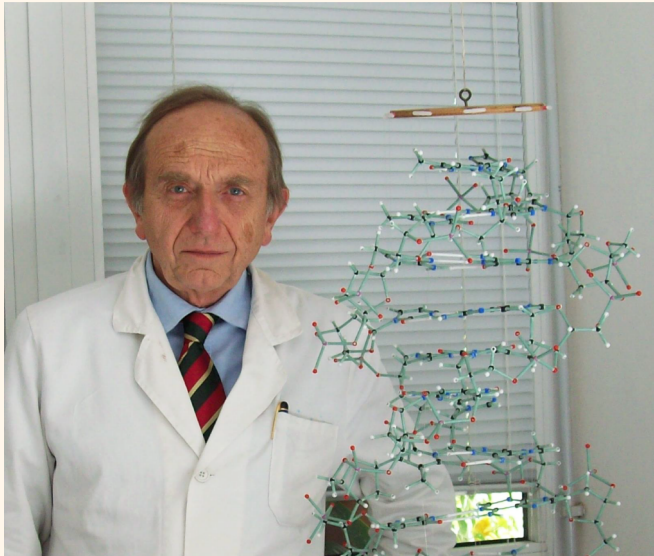
BIG QUANTUM BIOLOGY MEETINGS
HOSTED BY UCLA AND UNIVERSITY OF SURREY

- 14 Sep** Unravelling the key nuclear motions in photosynthetic exciton dynamics by coherent vibrational spectroscopy
Junwoo Kim, Chungbuk National University
- 21 Sep** Identifying productive protein thermal motions associated with hydrogen tunneling in the lipoxygenase reaction and their divergence across the enzyme family
Adam Offenbacher, East Carolina University
- 28 Sep** Schrodinger, Turing, and Hodgkin-Huxley: How mathematical analogies can inspire biological insights
Adam Cohen, Harvard University
- 5 Oct** From quantum states of biomolecules to quantum tools for nanobiological matter
Markus Arndt, University of Vienna
- 19 Oct** Nanomaterials for optical super-resolution imaging applications
Xiaomin Liu, Max Planck Institute for Polymer Research
- 26 Oct** Diamond quantum sensing microscopy of Fe-triazole spin crossover molecules and Fe-containing biomolecules
Abdelghani Laraoui, Univ. of Nebraska–Lincoln
- 2 Nov** Ionotronics: Exploring the path from biological to solid-state nanopores and back
Aleksandra Radenovic, École Polytechnique Fédérale de Lausanne (EPFL)
- 9 Nov** Site-specific terahertz spectroscopy of proteins
Maksim Grechko, Max Planck Institute for Polymer Research
- 16 Nov** Quenching and quenchers in photosynthesis
Roberta Croce, Vrije University Amsterdam
- 30 Nov** Intense pulsed electric field effects on proteins and cytoskeleton
Michal Cifra, Institute of Photonics and Electronics of the Czech Academy of Sciences
- 7 Dec** TBC, **Jessica Wade**, Imperial College London
- 14 Dec** Electron tunnelling in ferritin and associated biosystems
Ismael Díez-Pérez and **Chris Rourk**, King's College London and citizen scientist

See the Big Quantum meetings [website](#) for the Zoom details

COMMUNITY NEWS

CELEBRATING A PIONEERING CAREER: ALESSANDRO MORELLI



Professor Alessandro Morelli

One of the great pleasures of the expanding Guy Foundation community is meeting researchers who share our passion for subjects such as bioenergetics. We met with one such scientist in April this year when we were fortunate enough to meet with Alessandro Morelli who was in the UK to give a

seminar with Karl Morten at the Rosalind Franklin Institute. Professor Morelli has just retired from the University of Genoa, Italy and we thought this was a good opportunity to look back at his pioneering career in biochemical research.

Alessandro Morelli's interests intersect in many ways with those of The Guy Foundation, not least in his focus on oxidative phosphorylation and ATP production. What is so fascinating, however, is that he investigates these biological processes outside of their familiar location: the mitochondrion. He first set out on this path after his colleague, Isabella Panfoli, showed that cells that lack mitochondria – such as certain segments of rod cells in the eye – still produce a sizeable amount of ATP. Cells can produce ATP without oxygen and mitochondria via a process called glycolysis, but the

process in mitochondria, called oxidative phosphorylation, is vastly more efficient.

At the heart of oxidative phosphorylation is chemiosmosis, where the energy harnessed from electron transport chains is used to produce an electrochemical gradient, largely generated by pumping protons across the inner membrane of the mitochondrion. The energy in this gradient is then captured by creating the universal energy molecule in the cell, ATP, by combining ADP and phosphate by a turbine-like molecule called ATPase, via what appears to be a largely mechanical mechanism. This is fascinating in itself, and is research on which one of The Guy Foundation's scientific advisors, Professor Wayne Frasch, is a world expert.

It has been thought for a long time that the only place in a modern eukaryotic cell where this could take place was in the mitochondrion because it could generate this proton gradient and store it across a largely impermeable membrane. The key here is this has long been visualised as being very similar to a hydroelectric system, where the potential energy of water is created by storing it behind a dam. In effect, the protons stack up behind the ATPase and drive it. However, there have also been some hypotheses that rather than the protons flowing perpendicularly through the membrane, they might flow along it, which is still highly controversial. The implications are profound, as it means the oxidative phosphorylation doesn't necessarily have to take place in a closed dam-like system, but can simply occur if the protons are stored somewhere else along a membrane, possibly along hypothesised proton wires. Morelli's research, combined with others, could be suggesting nothing less than a complete paradigm shift in how chemiosmosis works.

His recent discovery that brain myelin might also serve as a location for oxidative phosphorylation outside of mitochondria, serving as an important source of energy for nerves, has important implications for all of biology. It could even extend into explaining the origins of life, since Morelli has highlighted close functional analogies between the very ancient cyanobacteria and myelin itself.

Furthermore, Morelli's proposal for the proton accumulator function of the myelin sheath paves the way for the fascinating hypothesis that myelin can accumulate protons during sleep to return them during wakefulness, which could profoundly impact our understanding of the brain.

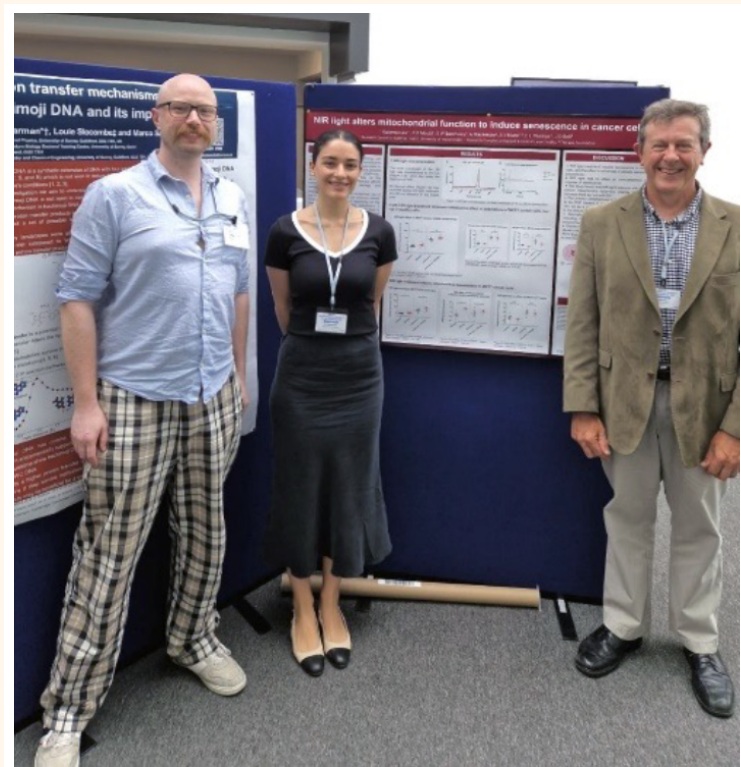
We wish Alessandro a happy retirement and thank him for his numerous insights and contributions in this field.

If you have any new appointments, awards or other news that would be of interest, please don't hesitate to let us know.

We hope you've enjoyed this edition of the newsletter. If you have some news that you'd like to share, comments on the newsletter or would like to unsubscribe, please email

n.copping@theguyfoundation.org

The Guy Foundation team



The Guy Foundation team at the QuEBS meeting in June 2023

Left to right: Alasdair Mackenzie (STFC-UKRI), Ifigeneia Kalampouka (University of Westminster) and Alistair Nunn (Director of Science, The Guy Foundation)

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