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2ND INTERNATIONAL SCIENCE,
ENGINEERING AND TECHNOLOGY
COLLOQUIUM



THE POWER OF SCIENTIFIC INNOVATION

INTELLIGENT SOLUTIONS FOR A
SUSTAINABLE WORLD

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PREFACE

Welcome to the 2nd International Science, Engineering and Technology Colloquium 2025 (ISETC 2025)!

It is with great pleasure that we present this year's colloquium, a distinguished gathering of scholars, researchers, and professionals dedicated to the advancement of applied sciences. Held virtually on 9th July 2025, ISETC 2025 serves as a platform to highlight cutting-edge research, foster meaningful networking, encourage collaborations, and explore innovative solutions to global challenges.

This year's theme, "The Power of Scientific Innovation: Intelligent Solutions for a Sustainable World" highlights our shared goal to solve global challenges through applied science. It celebrates innovation as a key to building a more sustainable and resilient future. We're proud to feature keynote speakers and presenters who bring fresh insights, bold ideas, and breakthroughs shaping tomorrow's world.

We would like to extend our heartfelt appreciation to the Faculty of Applied Sciences, Universiti Teknologi MARA, Perak Branch, Tapah Campus, for their outstanding support and assistance throughout the planning and execution of the event. Their dedication has been instrumental to the success of this colloquium. We would like to sincerely thank all participants and researchers for their valuable contributions. We also appreciate the reviewers for their careful evaluations and helpful feedback. Your hard work and support mean a lot to us.

As editors, we are proud to present this collection of proceedings. It is an honour to bring together the interesting and meaningful work of our speakers and authors. We hope the ideas shared will lead to new discoveries, encourage more research, and help solve global challenges through science and innovation.

Warm regards,

Dr. Emi Norzehan Mohamad Mahbob

Dr. Saiyidah Nafisah Hashim

Ms. Lili Widarti Zainuddin

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ISETC 2025 Proceedings Editors

EXPLORING THE INTERCONNECTIONS OF PHYSICS AND LIFE

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Abstract: The paper "Exploring the Interconnections of Physics and Life" dives into the interesting relationship between physics and numerous areas of life. It examines how fundamental physics concepts affect and shape biology, chemistry, environmental science, and everyday experiences. This study tries to shed light on the enormous impact of physics on our knowledge of life and the natural world by investigating the relationships between energy transfer, motion, electromagnetic, optics, and other physics topics. It emphasises the integration of physics concepts in the study of biological processes, chemical reactions, environmental dynamics, and sensory perception using an interdisciplinary approach. This research leads to a better understanding of the intricate systems that regulate human existence and opens new opportunities for interdisciplinary exploration and scientific achievements by unravelling the interdependence of physics and life.

Keywords: *Physics, biology, chemistry, environmental science, multidisciplinary*

INTRODUCTION

The intricate interplay between physics and life has been a subject of fascination for centuries. Physics, as the study of matter, energy, and the fundamental forces of nature, provides a lens through which we can understand and unravel the complexities of the living world. From the microscopic realm of cells to the vast expanse of ecosystems, physics influences and shapes various aspects of our existence. The aim of this research paper is to delve into the profound interconnections between physics and life, exploring how the principles and laws of physics manifest in biology, chemistry, environmental science, and even our everyday experiences. By examining the fundamental concepts of energy transfer, motion, thermodynamics, and quantum mechanics, we can uncover the underlying mechanisms that govern life processes and the natural world.

In biology, physics plays a crucial role in elucidating the energy conversion processes within cells, the biomechanics of organisms, and the transmission of electrical signals in the nervous system. Understanding the physics underlying these biological phenomena allows us to appreciate the intricacies of life at a fundamental level. In chemistry, the principles of physics are indispensable for understanding atomic structure, chemical reactions, and the behaviour of molecules. Thermodynamics, for instance, provides insights into chemical equilibrium and the energetics of chemical transformations. Quantum mechanics unveils the mysterious realm of molecular behaviour, shedding light on the forces that shape chemical interactions.

By exploring the interconnections between physics and life, this research paper aims to emphasize the significance of integrating physics concepts into our understanding of the natural world. It highlights the need for a multidisciplinary approach, fostering a deeper appreciation for the beauty, complexity, and interconnectedness of the universe. As we embark on this exploration, we unravel the mysteries that lie at the intersection of physics and life, paving the way for new insights, discoveries, and practical applications that enrich our understanding of the world we inhabit. The question of whether life exists elsewhere in the universe is another intriguing aspect of the study of biology. If life were to be found elsewhere, it would likely share fundamental similarities with life on Earth, given the universality of physical laws and the composition of matter. This perspective is rooted in the principle of the inexorability of life, which suggests that life arises inevitably under certain conditions (Gómez-Márquez, 2021).

Life, as a complex and multifaceted phenomenon, is defined through various lenses in biology, philosophy, and empirical science. F. Harold emphasizes that life encompasses a vast array of organisms, from bacteria to humans, and is characterized by organization and purposeful order, distinguishing it from inanimate matter. Simon Pierce proposes a definition of life as a self-regulating process that converts thermodynamic disequilibria into directed

motion, highlighting the role of molecular structures in metabolism and replication (Pierce, 2021). Meanwhile, Jaime Gómez-Márquez offers an alternative view, defining life as a preprogrammed, interactive, and adaptive process occurring within organized structures, and even includes viruses in this definition due to their evolutionary significance (Gómez-Márquez, 2021). Hegel's philosophical approach further enriches this discourse by framing life as a category that transcends mere physical phenomena, suggesting a deeper, logical understanding of life within the broader context of knowledge (Findlay, 1984). Collectively, these perspectives illustrate the ongoing exploration of what constitutes life, reflecting its intricate relationship with biological processes and philosophical inquiry. Beyond the realm of specialized scientific disciplines, physics also finds its way into our everyday lives. From the mechanics behind sports performance to the optics of vision and photography, and even the science of sound and acoustics, physics provides the foundational principles that underpin these experiences.

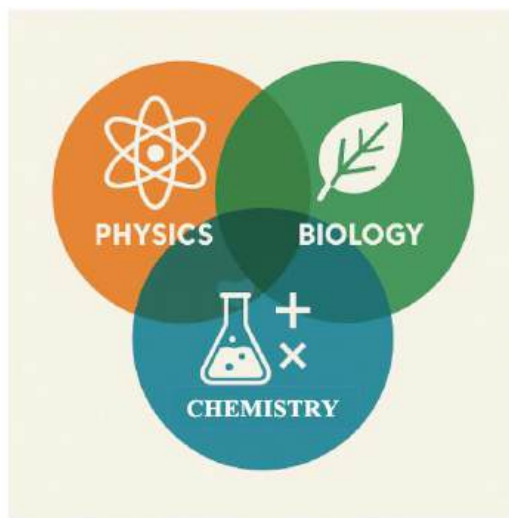


Figure 1. Union of physics, biology, and chemistry as a Venn diagram-style integration

MATERIALS AND METHODS

This study is structured into four sections to investigate the connections between physics and biology, chemistry, environmental science, and ordinary experiences. The first topic delves into the underlying concepts that underpin energy transfer, biomechanics, and electrical signaling in living organisms, focusing on the interface of biology and physics. The second topic investigates the link between chemistry and physics, focusing on physics' role in understanding molecular interactions, chemical processes, and thermodynamics within biological systems. The third section looks at the linkages between environmental science and physics, focusing on how physics principles help us comprehend energy transfer, climate dynamics, and the use of renewable resources. Finally, the paper investigates everyday experiences and emphasizes the widespread influence of physics, ranging from the mechanics of sports performance to optics of vision and sound science. While the division presents a general overview, the division's goal is to introduce the reader to the importance of physics knowledge in different elements of our environment, including the intricate workings of the human body.

RESULTS/DISCUSSION

Physics in Biology

Physics plays a significant role in understanding and explaining various phenomena in biology. Here are some key areas where physics concepts are applied in biology. The connections between biology and physics lie in the fundamental principles and laws that govern both disciplines. These connections arise from the shared underlying nature of the natural world and the application of scientific principles to understand its workings.

Table 1. Some key connections between biology and physics

Biology Concepts	Physics Concepts
Energy transfer in cells	Thermodynamics, Energy Conservation
Biomechanics of organisms	Newtonian Mechanics, Forces, Motion
Electrical signals in the nervous system	Electromagnetism, Electrical Circuits
DNA structure and replication	Molecular Physics, Chemical Bonds
Photosynthesis and light absorption	Optics, Electromagnetic Waves
Protein folding and conformation	Statistical Physics, Molecular Forces
Fluid dynamics in circulatory systems	Fluid Mechanics, Bernoulli's Principle
Cell membrane potential	Electrostatics, Electrical Potential
Bioenergetics and metabolic pathways	Thermodynamics, Enzyme Kinetics
Biological oscillations (e.g., circadian rhythms)	Oscillatory Systems, Resonance
Biophysics of hearing and vision	Wave Phenomena, Perception
Biomechanics of locomotion	Newtonian Mechanics, Biomechanical Forces

Note: The table presents a sample of connections between biology and physics concepts. The actual scope and depth of connections may vary depending on the specific topics and areas of study within biology and physics.

The connection between biology and physics is evident in various ways, as both disciplines are integral parts of the broader field of science. The interaction between biology and physics extends from the fundamental principles governing living organisms to the more complex phenomena observed at the molecular, cellular, and organismal levels. The principles of physics significantly enhance our understanding of biological systems at the molecular and cellular levels by providing a framework to model and predict complex biological behaviors. Statistical physics, for instance, is instrumental in addressing the non-equilibrium fluctuations observed in biological systems, such as the dynamics of microtubules and enzyme conformational changes, which are crucial for cellular processes and regulatory networks (Wu, 2011). The transition of biology from a molecular to a physical perspective allows for a more mechanistic understanding of cellular functions, enabling models with greater realism and predictive accuracy (Zhou, 2017). Textbooks like "Physical Biology of the Cell" emphasize the application of physical principles, such as electrostatics and molecular interactions, to biological systems, offering a structured approach to understanding cellular and molecular functions through physical laws (Elam, 2014). Furthermore, the multiscaling laws of molecular physics provide insights into the emergence of living systems from atomic chaos, highlighting the role of atomic vibrations and collisions in biological transformations like self-assembly and phenotype reorganization (Ortoleva et al., 2009). Additionally, the study of molecular biophysics, focusing on the electrical and dynamical behavior of biopolymers, underscores the importance of physical laws in explaining the structure and motion of biological molecules. Collectively, these approaches illustrate how physics not only aids in deciphering the complexities of biological systems but also bridges the gap between molecular dynamics and broader biological phenomena.

Chemistry and Physics

Chemistry and physics are closely related scientific disciplines, and they have numerous connections and overlaps. Chemistry and physics are intricately linked, with significant overlaps that manifest in various ways. Quantum chemistry serves as a pivotal bridge between the two disciplines, illustrating how chemical phenomena can be understood through physical principles, yet it also highlights the limitations of reductionism, as chemistry retains its unique identity despite its reliance on physics (Hetteema, 2017) (Chang, 2015). The emergence of fields like chemical physics exemplifies this convergence, where concepts from both areas are utilized to address complex scientific questions, including those in materials science and astrophysics. Furthermore, while physics provides foundational laws that govern chemical behavior, chemistry often operates independently, exploring mechanisms that may not be strictly dictated by physical laws. This dynamic relationship underscores the philosophical debates surrounding the nature of scientific disciplines and the extent to which one can be reduced to the other (Lombardi, 2014).

These connections highlight how physics provides the fundamental principles and laws governing the behavior of matter and energy, while chemistry applies those principles to understand and manipulate the properties and transformations of substances. The two disciplines complement each other, forming a strong foundation for scientific research and technological advancements.

Table 2. Some key connections between chemistry and physics

Physics Concepts	Chemistry Concepts
Study of fundamental particles and their interactions	Application of quantum mechanics to explain the electronic structure of atoms and molecules
Investigation of electromagnetic radiation and its properties	Utilization of spectroscopy to analyze chemical substances and study molecular structures
Exploration of thermodynamics and energy transformations	Application of thermodynamics to understand energy changes in chemical reactions
Study of solid-state physics and material properties	Utilization of materials science to develop new compounds and understand their behavior
Research on the behavior of matter at extreme temperatures and pressures	Application of high-pressure chemistry to investigate reactions under extreme conditions
Investigation of nuclear physics and radioactive decay	Application of radiochemistry to study the behavior of radioactive isotopes in chemical reactions
Study of particle physics and the fundamental forces of nature	Utilization of particle accelerators and colliders to create and study new elements and compounds
Exploration of quantum mechanics and wave-particle duality	Application of quantum mechanics to explain chemical bonding and molecular interactions
Research on the behavior of matter in condensed phases (liquids and solids)	Application of physical chemistry to study phase transitions, kinetics, and transport phenomena
Investigation of statistical mechanics and the behavior of large systems	Utilization of statistical thermodynamics to understand the properties of gases, solutions, and macromolecules

This table highlights some of the key areas where physics and chemistry intersect and collaborate, demonstrating the strong interconnections between the two disciplines.

Note: The table presents a sample of connections between chemistry and physics concepts. The actual scope and depth of connections may vary depending on the specific topics and areas of study within chemistry and physics.

Environmental Science and Physics

Environmental science and physics are interconnected in several ways. Physics provides fundamental principles and concepts that are essential for understanding various environmental processes and phenomena.

The fundamental principles of physics significantly enhance the understanding of environmental processes and phenomena by providing a framework for analyzing interactions between organisms and their surroundings. Environmental physics applies these principles to study issues such as climate change, pollutant movement, and ecosystem dynamics, emphasizing the quantitative relationships that govern these interactions (Sadiku et al., 2021). For instance, concepts from mechanics, thermodynamics, and radiation are crucial for understanding energy transfer, pollutant dispersion, and the physiological responses of organisms to environmental changes (Chandrappa & Das, 2021; Monteith & Unsworth, 2013). Moreover, the application of physical laws aids in the development of technologies for pollution control and environmental monitoring, thereby facilitating informed decision-making for environmental stewardship (Cribs, 2022). This interdisciplinary approach underscores the importance of physics in addressing complex environmental challenges and promoting sustainable practices.

These interconnections highlight how physics provides a fundamental understanding of the physical processes that underlie various environmental phenomena. Environmental science draws on physics principles, theories, and methodologies to investigate and address environmental challenges, leading to a holistic and interdisciplinary approach to studying and managing the environment.

CONCLUSIONS

The interplay between physics and life reveals a deeply unified tapestry underlying natural phenomena. From the quantum mechanics that dictate molecular behavior in biochemistry, to the thermodynamics that govern cellular metabolism, and the electromagnetic forces that enable neural signaling and photosynthesis, physics provides the foundational rules that shape biological and chemical systems. In environmental science, physical laws explain climate dynamics, energy transfer, and ecological stability, highlighting the planetary-scale relevance of these principles. By tracing these laws across disciplines, life itself is not separate from the physical universe but a remarkable expression of its order. Understanding this unity empowers us to solve complex challenges from designing targeted medical therapies to engineering sustainable technologies by leveraging the shared language of physics across all domains of life and matter.

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Sekian, terima kasih.

"BERKHIDMAT UNTUK NEGARA"

Saya yang menjalankan amanah,

Setuju.

27.1.2023

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