BIOELECTRICITY
Volume 6, Number 1, 2024
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DOI: 10.1089/bioe.2024.29035.editorial

Editorial

Bioelectricity: An Interdisciplinary Bridge into the Future

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We begin this 6th year of *Bioelectricity* with significant excitement toward the future. Our first 5 years have spanned all areas of the field, covering many scales of size, diverse disciplines, and the gamut from very basic science to clinical applications. We would like to highlight a few major themes that we are anticipating in the field.

The first is the rapidly spreading use of AI in all areas of information sciences and industry. The field of bioelectricity is an area of research which will experience significant acceleration due to the use of machine learning in the stages of discovery and application. The use of AI-controlled automation will mean that physiomics data (voltage, ion, and electric field measurements) will become feasible at a much higher throughput than ever before, in a range of model systems. Automated experiments have already begun in other areas such as genetics, biochemistry, and metabolism, via the ''robot scientist'' platforms that can not only collect data but also actually design and run experiments. These are not replacements, but rather powerful assistants for human knowledge-workers and researchers. Bioelectricity will surely benefit from this, especially when coupled to 4D real-time physiology imaging technology, and thus bring forth the first truly Big Data in the field.

The next stage of AI's impact will be in processing the data to truly begin to crack the Bioelectric Code. Machine learning tools, and especially ''White Box'' models that assist understanding (not merely prediction), can help infer the mappings between bioelectric states and downstream transcriptional and anatomical outcomes. The electromics datasets will be mined by the powerful pattern-matching capabilities of new AI architectures, to identify signatures of impending disease as well as infer actionable models that can be used to pick drugs and other kinds of electroceuticals for desired outcomes *in vitro* and *in vivo*.

The second related field to which we want to draw attention is that of Diverse Intelligence—a multidisciplinary effort to understand how evolution exploits the properties of biophysics to implement memory, integrated information processing, prediction, and decision-making in a wide range of substrates. Bioelectricity is well known to neuroscientists as the ''cognitive glue'' which enables a collection of neural cells to develop not only efficient behavior but also an inner perspective that feels like a unified emergent Self. But this role—of being the computational medium of cellular (and organelle) collective intelligence—goes well beyond the brain. It enables embryogenesis, regeneration, remodeling, metamorphosis, and the resistance to cancer and aging. Not only that, bioelectrical pathways literally implement the mind–body connection: our executive-level goals and voluntary intent can make ions dance across muscle membranes to enable the behavior that links thoughts to actions. The body's bioelectric systems enable the computations that define our cognitive states, our plans and dreams, and then transduce them to allow mind to control the biochemistry of our bodies.

These are not all. Already moving from the laboratory to the field are approaches like optogenetics and CRISPR and the new discipline of ''cancer neuroscience,'' where bioelectricity is one of the main bridges, will continue to gain momentum. We can also expect increasing commercial and clinical applications of techniques like ''electroporation'' and bioelectric materials.

Thus, the field of bioelectricity is ideally placed to contribute to the crucial effort to develop a comprehensive understanding of the evolution and function of not only our conventional mind but also of the diverse, poorly understood, problem-solving intelligences that are embodied in our organs, in our biobots, and in our hybrid devices. Indeed, there is every chance that we shall see a plethora of cyborg beings in the next decades. The bioelectric networks that enable self-assembly and repair of body structures are an ideal model system in which to understand how adaptive, goal-directed behavior can arise.

We look forward to more papers that not only explore bioelectricity in conventional directions of science and engineering but also extend to fields that can be impacted by it, including philosophy of mind, ecology, exobiology, and unconventional computing. We encourage everyone to continue to send in interesting manuscripts that emerge from this fascinating field, and reinforce our commitment to a uniquely smooth and productive process for authors.

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