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Editorial
Living Communication

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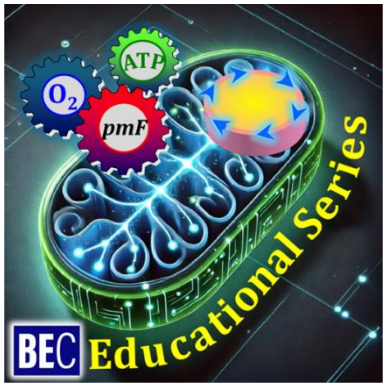
Editors
The authors are Editors of the BEC Educational Series *Elements of mitochondrial physiology and bioenergetics*.

Introductory to advanced



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BEC Educational Series – Elements of mitochondrial physiology and bioenergetics

Erich Gnaiger[1], Luiza HD Cardoso[1], Christopher Axelrod[2], Steven C Hand[3]

[1] Oroboros Instruments, Innsbruck, Austria
[2] Pennington Biomedical Research Center, Baton Rouge, LA, USA
[3] Department of Biological Sciences, Louisiana State University, Baton Rouge, LA, USA

Corresponding author: erich.gnaiger@oroboros.at

Effective communication is crucial for bridging the gap between specialized knowledge and the understanding of common needs among students and scientists, medical professionals and patients, academia and the public. Facilitating effective communication about mitochondria is a challenge across diverse audiences. While the need for harmonization of scientific terminology in bioenergetics and mitochondrial physiology has been recognized in peer-to-peer communication, the perspective must be widened by including newcomers to the field. The BEC Educational Series delves into fundamental concepts of mitochondrial biology and bioenergetics, elucidates key terminology, and provides practical guidance for conveying complex scientific information in common language without compromising accuracy. Drawing upon insights from mitochondrial research and experience in communicating bioenergetics, this resource equips readers with the knowledge and vocabulary necessary to engage in meaningful discussions about mitochondrial function, dysfunction, therapeutic interventions, and the scientific missions of bioenergetics.

The mitochondria, known as the powerhouses of the cell, play a crucial role in our body. Their intricate functions are not only of paramount importance to scientists and medical professionals but hold significant relevance for all of us interested in

mitochondrial health and disorders, lifestyle and sports, evolution and the diversity of aerobic life on our planet. Educating the scientific community and the broader public about mitochondria is essential for fostering understanding and support for research and healthcare initiatives in this field. The BEC Educational Series is conceived as a quality-controlled Open Educational Resource [9].

Effective communication about mitochondria among scientists, medical professionals, and the public is essential for advancing our understanding of these organelles — their role in health and disease, and potential treatment strategies. However, this exchange is often complicated by differences in terminology. 'Code-switching' is necessary not only when explaining concepts to a lay audience [8] but also within the scientific community itself, where distinct fields develop their own specialized jargon. Bridging these linguistic gaps while maintaining accuracy presents a challenge: simplifying complex ideas without distorting fundamental principles.

Misinterpretations arise when scientific concepts are conveyed ambiguously through 'popular' language or 'trendy' graphical representations [3]. For example, the notion that mitochondria *produce* energy is a widespread misconception that contradicts the first law of thermodynamics — they *transform* energy. Gibbs or Helmholtz 'free' energy must be distinguished from forces driving chemical reactions such as the protonmotive force [5]. Body weight is a force distinct from body mass. While educational websites are proliferating online, many lack quality control. Open peer review should disclose persistent challenges and bring the process of bioenergetics communication in front of the curtain.

We invite contributions that are engaging, accessible, and educational. Provide the essential background knowledge to help readers appreciate current advancements in the field. To improve clarity, we suggest breaking down complex topics into separate contributions with simple, straightforward titles. Authors and readers are not forced into a linear sequence of textbook-chapters but can follow a modular approach.

Our goal is to encourage specialists to use *precise* language in scientific publications. A *common* language ensures that technical terms are meaningful and widely understood in conversations. Carefully selecting terminology — balancing accessibility with scientific accuracy — helps bridging the gaps between experts and non-specialists alike. The BEC editorial team strives to improve consistency in terminology and symbols across the BEC Educational Series, so that readers are not confronted with different 'languages' in various articles. SI standards should be rigorously followed [1]. Recommendations for harmonizing terminology in bioenergetics [6] may serve as a guideline. Electron transfer and oxidative phosphorylation are core elements of bioenergetics. There is no established committee that suggests the acronym OXPHOS; it is adopted simply because OXPHOS is more commonly used than OxPhos. Strong arguments support replacing the frequently used term electron transport chain ETC with electron transfer system ETS [7]. The conflict is avoided when referring to ET capacity. Related to OXPHOS and ET, LEAK

respiration [6] and ROUTINE respiration [2] follow a consistent format. However, in a sentence on routine respiration, the upper case ROUTINE may appear overly technical and disrupt the text's flow. Therefore, we encourage adopting a more relaxed approach, favoring the simpler lowercase style in reference to leak and routine cell respiration [4].

A didactic synopsis outlining 3–5 key teaching points can help establish a clear learning focus. The recommended format is approximately 10 to 12 pages. Figure legends may not be required when figures are placed in the appropriate context of the text. Unlike traditional reviews, this format is designed to resemble short textbook sections, prioritizing clarity and education. Educational diagrams and schematics are highly encouraged, and a glossary or list of symbols may be included to define key terms in plain language. References listed under 'Further reading' may be restricted to suggest accessible resources.

Communications are aimed at either a general audience or advanced students and scientists. Contributions to the BEC Educational Series are accepted by invitation only. To enhance the readability of 'introductory' contributions, we propose involving early-career students or educated non-specialists as volunteer reviewers. This complements, rather than replaces, peer review. Ask four to eight volunteers to read your manuscript carefully, twice. During the first reading, they should focus on understanding definitions. On the second, they should identify any terms or contexts that remain unclear. Feedback from such volunteers has challenged multiple drafts of a first 'introductory' communication [4]. Ideally, no more than one or two unclear terms per page should remain, ensuring that students stay engaged and motivated. If confusion arises too frequently, refine explanations. Complex concepts may instead be addressed in 'advanced' communications — for example, on the protonmotive force as one of the core concepts in bioenergetics [5].

Upon acceptance of a manuscript following peer review, we encourage authors to team up with colleagues to provide translations in other languages relevant to bioenergetics education. Multilingual access enhances comprehension, as the nuances of scientific concepts can be better appreciated through diverse linguistic frameworks. Embracing cultural pluralism in science fosters international dialogue beyond political and linguistic barriers. Translations — credited to the translators as co-authors — will undergo peer review by a single expert fluent in the respective language and will be published alongside the original English version. This is different from the concept of *Living Communications*, which are updated editions of a publication when relevant improvements are warranted.

Developing a shared language is essential — within bioenergetics, the field that explores energy transformations in mitochondria, chloroplasts, and bacteria — and beyond. Whether you are a scientist studying mitochondrial bioenergetics, a medical professional diagnosing and treating mitochondrial disorders, a patient seeking to understand your mitochondrial health, or simply someone curious about cellular energy

metabolism, this resource aims to enhance clarity, foster collaboration, and deepen understanding of mitochondrial health and disease.

Further reading

1. Bureau International des Poids et Mesures (2019) The International System of Units (SI). 9th edition:117-216. ISBN 978-92-822-2272-0
2. Gnaiger E (2020) Mitochondrial pathways and respiratory control. An introduction to OXPHOS analysis. 5th ed. Bioenerg Commun 2020.2. https://doi.org/10.26124/bec:2020-0002
3. Gnaiger E (2024) Complex II ambiguities — $FADH_2$ in the electron transfer system. https://doi.org/10.1016/j.jbc.2023.105470
4. Gnaiger E (2025) Mitochondrial respiratory function in living cells. https://doi.org/10.26124/bec.2025-0005
5. Gnaiger E (2025) The protonmotive force – from motive protons to membrane potential. https://doi.org/10.26124/becprep.2025-0003
6. Gnaiger E et al — MitoEAGLE Task Group (2020) Mitochondrial physiology. https://doi.org/10.26124/bec:2020-0001.v1
7. Hatefi Y, Haavik AG, Fowler LR, Griffiths DE (1962) Studies on the electron transfer system XLII. Reconstitution of the electron transfer system. https://doi.org/10.1016/S0021-9258(19)73804-6
8. Petzold AM, Dunbar RL (2018) The art of talking about science: beginning to teach physiology students how to communicate with nonscientists. https://doi.org/10.1152/advan.00053.2017
9. Wiley D, Bliss TJ, McEwen M (2014) Open educational resources: a review of the literature. In: Spector J, Merrill M, Elen J, Bishop M (eds) Handbook of research on educational communications and technology. Springer, New York:781-9. https://doi.org/10.1007/978-1-4614-3185-5_63