

**OPEN ACCESS**

EDITED BY

Grzegorz Wegrzyn,
University of Gdansk, Poland

*CORRESPONDENCE

Michał Rurek,
✉ rurek@amu.edu.pl
Jarosław Czyż,
✉ jarek.czyz@uj.edu.pl
Zbigniew Heleniak,
✉ zbigniew.heleniak@gumed.edu.pl
Paulina Niedźwiedzka-Rystwej,
✉ paulina.niedzwiedzka-rystwej@usz.edu.pl
Witold N. Nowak,
✉ witold.nowak@uj.edu.pl
Milena Paw,
✉ milena.paw@uj.edu.pl
Dawid Wnuk,
✉ dawid.wnuk@uj.edu.pl

RECEIVED 16 October 2025

REVISED 18 October 2025

ACCEPTED 31 October 2025

PUBLISHED 07 November 2025

CITATION

Rurek M, Czyż J, Heleniak Z,
Niedźwiedzka-Rystwej P, Nowak WN,
Paw M and Wnuk D (2025) Editorial: *Acta
Biochimica Polonica reviews*
| 2023–2024.
Acta Biochim. Pol. 72:15744.
doi: 10.3389/abp.2025.15744

COPYRIGHT

© 2025 Rurek, Czyż, Heleniak,
Niedźwiedzka-Rystwej, Nowak, Paw
and Wnuk. This is an open-access article
distributed under the terms of the
Creative Commons Attribution License
(CC BY). The use, distribution or
reproduction in other forums is
permitted, provided the original
author(s) and the copyright owner(s) are
credited and that the original
publication in this journal is cited, in
accordance with accepted academic
practice. No use, distribution or
reproduction is permitted which does
not comply with these terms.

Editorial: *Acta Biochimica Polonica reviews* | 2023–2024

Michał Rurek^{1*}, Jarosław Czyż^{2*}, Zbigniew Heleniak^{3*},
Paulina Niedźwiedzka-Rystwej^{4*}, Witold N. Nowak^{5*},
Milena Paw^{2*} and Dawid Wnuk^{2*}

¹Department of Molecular and Cellular Biology, Institute of Molecular Biology and Biotechnology, Faculty of Biology, Adam Mickiewicz University, Poznań, Poland, ²Department of Cell Biology, Faculty of Biochemistry, Biophysics and Biotechnology, Jagiellonian University in Kraków, Kraków, Poland, ³Department of Nephrology, Transplantology and Internal Medicine, Medical University of Gdańsk, Gdańsk, Poland, ⁴Institute of Biology, University of Szczecin, Szczecin, Poland, ⁵August Chetkowski Institute of Physics, Faculty of Science and Technology, University of Silesia in Katowice, Chorzów, Poland

KEYWORDS

cardiovascular health, microbiota, mitochondria, potassium channels, plant transcriptome

Editorial on the Special Issue***Acta Biochimica Polonica reviews* | 2023–2024**

The aim of the Special Issue “*Acta Biochimica Polonica Reviews* | 2023–2024” published in *Acta Biochimica Polonica* was to gather review articles from various research areas, focusing on cellular and molecular biology, and biomedicine. This editorial paper provides a concise overview of four publications published within the frames of this Special Issue.

Plant transcriptomes are highly complex entities shaped by a multitude of stressors in a spatiotemporally heterogeneous manner (Imadi et al., 2015). Numerous abiotic stressors represent part of the normal ecological niche to which plants are adapted, often triggering constitutive or primed stress-response programs. Two papers published in the Special Issue, the first (Rurek) and the third (Rurek and Smolibowski), provide a deepened meta-analysis of differences in plant transcriptomes under the impact of various stressors and across diverse vegetative and generative organs and tissues. Data were taken from numerous model, crop and medicinal plant species, and from various transcriptomic platforms, including single cell and spatial RNA-seq (Peirats-Llobet et al., 2023; Wang et al., 2024; Guo et al., 2025). The enriched gene ontology terms from affected gene families and the respective transcription factors were compared. The supplementary data in both papers provide summary of quantitative alterations in gene expression patterns and details on experimental conditions. In their review, Rurek and Smolibowski compared dynamic transcriptomic responses to selected abiotic and biotic stressors (Wang et al., 2020). Stress responses involved both species/stressor-specific but also shared gene families (coding mostly photosynthetic proteins and secondary metabolism enzymes). In turn, Rurek aimed to characterize the most relevant spatiotemporal transcriptomic responses in selected vegetative and generative plant organs and tissues in the developmental context (Huang et al., 2016). The dynamicity of

organ/tissue-specific responses was also compared in the context of the complexity and diversity of recently characterized plant genomes and transcriptomes. The specificity of organ/tissue-specific transcriptomes related to the over-representation of certain gene families and transcription factors was also emphasized. In addition, the perspectives for the application of medicinal plant species in industrial synthesis of valuable secondary metabolites were outlined based on organ-specific transcriptomic responses (Guo et al., 2021).

From the reviews by Rurek and Smolibowski and Rurek, the relevance of current plant transcriptomic studies both for basic research as well as for agriculture can be envisioned. Functional analyzes would allow for better characterization of stress-responsive genes and less-known stress acclimatory mechanisms. On this basis, more stress-resistant crop cultivars could be designed in the future, based on advanced tools of plant biotechnology (Sriboon et al., 2020; Liu et al., 2024). Such actions should also benefit more from plant metabolome heterogeneity. More consistent usage of the potential of medicinal species in the synthesis of pharmaceutically important compounds may help to combat a range of lifestyle-related diseases.

Modulation of the gut microbiome is another promising option to deal with the fatal increase in lifestyle-related diseases. The second paper in the Special Issue (Gofron et al.) provides the meta-analysis of the complex effects of *Akkermansia muciniphila* (*A. muciniphila*) on human health and their therapeutic applications. This facultatively anaerobic, gram-negative microbial species, initially isolated in 2004, colonizes the mucosa of the colon and rectum crypts and specializes in mucin degradation. Intensity of crypt colonisation by *A. muciniphila* correlates with the increased likelihood of colorectal cancer (Derrien et al., 2010; Nath and Mukherjee, 2014). However, available data also indicate the participation of *A. muciniphila* in cobalamin biogenesis and in the maintenance of intestinal and cardiovascular health; these bacteria hamper endothelium inflammation and atherosclerosis (Shin et al., 2014; Li et al., 2016; Mok et al., 2020). By various cellular and molecular mechanisms, they control body weight and cardiovascular disorders, including atrial fibrillation, and can be used in obesity therapy (Dao et al., 2016; Depommier et al., 2019; Luo et al., 2022). *A. muciniphila* also participates in the biogenesis of the intestinal mucosa layer and in the host protection against several inflammatory diseases (Qu et al., 2021). However, because of the limited number of reports, the interconnections between these activities and their general effects on human welfare need further exploration. In addition, the safety and potential of consuming living cultures of *A. muciniphila* to maintain their positive cardiovascular effects, as well as more specialized studies on the impact of *A. muciniphila* on the circulatory system should be investigated.

For a long time, mitochondria were mainly regarded as the centers of bioenergetical processes and cellular metabolism. Novel aspects of mitochondria function include their participation in cytoprotection, cellular senescence, tumorigenesis, fibrosis and inflammatory responses (Li et al., 2020; Barrera et al., 2021;

Chapa-Dubocq et al., 2023; Szabo and Szweczyk, 2023). The fourth publication of this Issue, a mini-review by Szweczyk, focuses on recent findings concerning the role of mitochondrial K-dependent (mitoK) channels in the regulation of mitochondrial and cellular physiology. The discovery of mitoK channels in 1991 (Inoue et al., 1991), although initially underestimated, led to their recognition as crucial players in multiple aspects of mitochondrial biogenesis across various taxa (Koszela-Piotrowska et al., 2009; Laskowski et al., 2015; Szabo and Szweczyk, 2023). In this paper, the research of multiple mitochondrial K-dependent channels were first summarized in historical context. Next, fundamental observations and most important ideas on their biological significance were discussed, with the emphasis on the regulation of reactive oxygen species (ROS) generation, membrane potential, respiration and the integrity of the mitochondrial inner membrane (Bednarczyk et al., 2013; Kulawiak et al., 2023). Moreover, the role of mitoK channels in cardio/neuroprotection and inflammation was stressed along with their function as the regulators of the cell fate (Liu et al., 1999; Garlid, 2000; Garlid et al., 2003; Busija et al., 2004; Leanza et al., 2014; Barrera et al., 2021). Broad activities of mitoK channels discovered so far indicate that the development of specific mitoK channel-specific inhibitors, new approaches for *in situ* monitoring of mitoK channel activity, and new routes for broadening our knowledge on molecular identity of mitoK channels would be helpful for their application as targets in medicine.

In conclusion, these four studies collectively provide valuable insights into various aspects of molecular, cellular biology as well as biomedicine. Although the spectrum of topics discussed in these papers is relatively broad, they emphasize the need for more deepened studies involving advanced methodological solutions to gain better insights into investigated biological processes and their regulation. These contributions underscore the growing importance of integrating molecular and physiological data. The translational potential of such research is evident: organ-specific plant transcriptomics offers opportunities for optimized production of bioactive compounds, *A. muciniphila* emerges as a promising microbiome-based tool for metabolic and cardiovascular disease prevention, and mitoK channels represent novel therapeutic targets in cardio- and neuroprotection. Such integrative and interdisciplinary approaches will not only deepen our mechanistic understanding, but also open new avenues for translational applications in biotechnology and medicine.

Author contributions

The Editorial was written by JC, ZH, PN-R, WN, MP, MR, and DW. MR provided a first draft of the manuscript and JC, ZH, PN-R, WN, MP and DW corrected it, added additional text and finalized. All authors contributed to the article and approved the submitted version.

Funding

The author(s) declare that no financial support was received for the research and/or publication of this article.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

References

- Barrera, M.-J., Aguilera, S., Castro, I., Carvajal, P., Jara, D., Molina, C., et al. (2021). Dysfunctional mitochondria as critical players in the inflammation of autoimmune diseases: potential role in Sjögren's syndrome. *Autoimmun. Rev.* 20, 102867. doi:10.1016/j.autrev.2021.102867
- Bednarczyk, P., Wieckowski, M. R., Broszkiewicz, M., Skowronek, K., Siemen, D., and Szewczyk, A. (2013). Putative structural and functional coupling of the mitochondrial BK_{Ca} channel to the respiratory chain. *PLoS One* 8, e68125. doi:10.1371/journal.pone.0068125
- Busija, D. W., Lacza, Z., Rajapakse, N., Shimizu, K., Kis, B., Bari, F., et al. (2004). Targeting mitochondrial ATP-sensitive potassium channels—a novel approach to neuroprotection. *Brain Res. Rev.* 46, 282–294. doi:10.1016/j.brainresrev.2004.06.011
- Chapa-Dubocq, X. R., Rodríguez-Graciani, K. M., Escobales, N., and Javadov, S. (2023). Mitochondrial volume regulation and swelling mechanisms in cardiomyocytes. *Antioxidants* 12, 1517. doi:10.3390/antiox12081517
- Dao, M. C., Everard, A., Aron-Wisniewsky, J., Sokolovska, N., Prifti, E., Verger, E. O., et al. (2016). *Akkermansia muciniphila* and improved metabolic health during a dietary intervention in obesity: relationship with gut microbiome richness and ecology. *Gut* 65, 426–436. doi:10.1136/gutjnl-2014-308778
- Depommier, C., Everard, A., Druart, C., Plovier, H., Van Hul, M., Vieira-Silva, S., et al. (2019). Supplementation with *Akkermansia muciniphila* in overweight and obese human volunteers: a proof-of-concept exploratory study. *Nat. Med.* 25, 1096–1103. doi:10.1038/s41591-019-0495-2
- Derrien, M., van Passel, M. W., van de Bovenkamp, J. H., Schipper, R., de Vos, W., and Dekker, J. (2010). Mucin-bacterial interactions in the human oral cavity and digestive tract. *Gut Microbes* 1, 254–268. doi:10.4161/gmic.1.4.12778
- Garlid, K. D. (2000). Opening mitochondrial K_{ATP} in the heart – what happens, and what does not happen. *Basic Res. Cardiol.* 95, 275–279. doi:10.1007/s003950070046
- Garlid, K. D., Dos Santos, P., Xie, Z.-J., Costa, A. D. T., and Paucek, P. (2003). Mitochondrial potassium transport: the role of the mitochondrial ATP-sensitive K⁺ channel in cardiac function and cardioprotection. *Biochimica Biophysica Acta (BBA) - Bioenergetics* 1606, 1–21. doi:10.1016/S0005-2728(03)00109-9
- Guo, J., Huang, Z., Sun, J., Cui, X., and Liu, Y. (2021). Research progress and future development trends in medicinal plant transcriptomics. *Front. Plant Sci.* 12, 691838. doi:10.3389/fpls.2021.691838
- Guo, X., Wang, Y., Zhao, C., Tan, C., Yan, W., Xiang, S., et al. (2025). An *Arabidopsis* single-nucleus atlas decodes leaf senescence and nutrient allocation. *Cell* 188, 2856–2871.e16. doi:10.1016/j.cell.2025.03.024
- Huang, Q., Huang, X., Deng, J., Liu, H., Liu, Y., Yu, K., et al. (2016). Differential gene expression between leaf and rhizome in *Atractylodes lancea*: a comparative transcriptome analysis. *Front. Plant Sci.* 7, 348. doi:10.3389/fpls.2016.00348
- Imadi, S. R., Kazi, A. G., Ahanger, M. A., Gucel, S., and Ahmad, P. (2015). Plant transcriptomics and responses to environmental stress: an overview. *J. Genet.* 94, 525–537. doi:10.1007/s12041-015-0545-6
- Inoue, I., Nagase, H., Kishi, K., and Higuti, T. (1991). ATP-sensitive K⁺ channel in the mitochondrial inner membrane. *Nature* 352, 244–247. doi:10.1038/352244a0
- Koszela-Piotrowska, I., Matkovic, K., Szewczyk, A., and Jarmuszkiewicz, W. (2009). A large-conductance calcium-activated potassium channel in potato (*Solanum tuberosum*) tuber mitochondria. *Biochem. J.* 424, 307–316. doi:10.1042/BJ20090991
- Kulawiak, B., Żochowska, M., Bednarczyk, P., Galuba, A., Stroud, D. A., and Szewczyk, A. (2023). Loss of the large conductance calcium-activated potassium channel causes an increase in mitochondrial reactive oxygen species in glioblastoma cells. *Pflügers Archiv - Eur. J. Physiology* 475, 1045–1060. doi:10.1007/s00424-023-02833-9

Generative AI statement

The author(s) declare that no Generative AI was used in the creation of this manuscript.

Any alternative text (alt text) provided alongside figures in this article has been generated by Frontiers with the support of artificial intelligence and reasonable efforts have been made to ensure accuracy, including review by the authors wherever possible. If you identify any issues, please contact us.

- Laskowski, M., Kicinska, A., Szewczyk, A., and Jarmuszkiewicz, W. (2015). Mitochondrial large-conductance potassium channel from *Dictyostelium discoideum*. *Int. J. Biochem. and Cell Biol.* 60, 167–175. doi:10.1016/j.biocel.2015.01.006

- Leanza, L., Zoratti, M., Gulbins, E., and Szabo, I. (2014). Mitochondrial ion channels as oncological targets. *Oncogene* 33, 5569–5581. doi:10.1038/onc.2013.578

- Li, J., Lin, S., Vanhoutte, P. M., Woo, C. W., and Xu, A. (2016). *Akkermansia muciniphila* protects against atherosclerosis by preventing metabolic endotoxemia-induced inflammation in *Apoe*^{−/−} mice. *Circulation* 133, 2434–2446. doi:10.1161/circulationaha.115.019645

- Li, X., Zhang, W., Cao, Q., Wang, Z., Zhao, M., Xu, L., et al. (2020). Mitochondrial dysfunction in fibrotic diseases. *Cell Death Discov.* 6, 80. doi:10.1038/s41420-020-00316-9

- Liu, Y., Sato, T., Seharaseyon, J., Szewczyk, A., O'Rourke, B., and Marbán, E. (1999). Mitochondrial ATP-Dependent potassium channels: viable candidate effectors of ischemic preconditioning. *Ann. N. Y. Acad. Sci.* 874, 27–37. doi:10.1111/j.1749-6632.1999.tb09222.x

- Liu, D., Ellison, E. E., Myers, E. A., Donahue, L. I., Xuan, S., Swanson, R., et al. (2024). Heritable gene editing in tomato through viral delivery of isopentenyl transferase and single-guide RNAs to latent axillary meristematic cells. *Proc. Natl. Acad. Sci. U.S.A.* 121, e2406486121. doi:10.1073/pnas.2406486121

- Luo, Y., Zhang, Y., Han, X., Yuan, Y., Zhou, Y., Gao, Y., et al. (2022). *Akkermansia muciniphila* prevents cold-related atrial fibrillation in rats by modulation of TMAO induced cardiac pyroptosis. *eBioMedicine* 82, 104087. doi:10.1016/j.ebiom.2022.104087

- Mok, K. C., Sokolovskaya, O. M., Nicolas, A. M., Hallberg, Z. F., Deutschbauer, A., Carlson, H. K., et al. (2020). Identification of a novel cobamide remodeling enzyme in the beneficial human gut bacterium *Akkermansia muciniphila*. *mBio* 11, e02507–e02520. doi:10.1128/mbio.02507-20

- Nath, S., and Mukherjee, P. (2014). MUC1: a multifaceted oncoprotein with a key role in cancer progression. *Trends Mol. Med.* 20, 332–342. doi:10.1016/j.molmed.2014.02.007

- Peirats-Llobet, M., Yi, C., Liew, L. C., Berkowitz, O., Narsai, R., Lewsey, M. G., et al. (2023). Spatially resolved transcriptomic analysis of the germinating barley grain. *Nucleic Acids Res.* 51, 7798–7819. doi:10.1093/nar/gkad521

- Qu, S., Fan, L., Qi, Y., Xu, C., Hu, Y., Chen, S., et al. (2021). *Akkermansia muciniphila* alleviates dextran sulfate sodium (DSS)-induced acute colitis by NLRP3 activation. *Microbiol. Spectr.* 9, e00730-21. doi:10.1128/spectrum.00730-21

- Shin, N.-R., Lee, J. C., Lee, H. Y., Kim, M. S., Whon, T. W., Lee, M. S., et al. (2014). An increase in the *Akkermansia* spp. population induced by metformin treatment improves glucose homeostasis in diet-induced obese mice. *Gut* 63, 727–735. doi:10.1136/gutjnl-2012-303839

- Sriboon, S., Li, H., Guo, C., Senkhamwong, T., Dai, C., and Liu, K. (2020). Knockout of *TERMINAL FLOWER 1* genes altered flowering time and plant architecture in *Brassica napus*. *BMC Genet.* 21, 52. doi:10.1186/s12863-020-00857-z

- Szabo, I., and Szewczyk, A. (2023). Mitochondrial ion channels. *Annu. Rev. Biophys.* 52, 229–254. doi:10.1146/annurev-biophys-092622-094853

- Wang, X., Li, N., Li, W., Gao, X., Cha, M., Qin, L., et al. (2020). Advances in transcriptomics in the response to stress in plants. *Glob. Med. Genet.* 07, 030–034. doi:10.1055/s-0040-1714414

- Wang, H., Xu, Y., Zhang, Z., Zhang, G., Tan, C., and Ye, L. (2024). Development and application of transcriptomics technologies in plant science. *Crop Des.* 3, 100057. doi:10.1016/j.crope.2024.100057