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EDITORIAL

Telomeres in health and longevity: special issue in memory of Alexey Olovnikov

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Abstract In this special issue we commemorate theoretical biologist Alexey Olovnikov (1936–2022), whose theory of marginotomy has laid the foundation for the new field of biology that studies the molecular structure of telomeres and its role in health, longevity and aging. This issue contains a collection of reviews and research articles that discuss different aspects of telomere and telomerase research, ranging from telomere length dynamics in wild animal populations to problems of telomere maintenance during human space flight.

Keywords Telomeres · Aging · Marginotomy · End-replication · Cellular senescence · Lifespan · Healthspan

This special issue and online article collection is dedicated to Alexey M. Olovnikov (10 October 1936–06 December 2022), a theoretical biologist best known for his visionary work on the role of telomeres in aging (Olovnikov 1971, 1973). This work, which turned 50 last year, predicted all the key aspects of telomere biology: incomplete replication of terminal DNA of linear chromosomes (marginotomy), limited cell division potential determined by the length of telomeres, the need for a specialized DNA polymerase that compensates for marginotomy (now known as telomerase), the role of telomeres in cellular and organismal aging, and potential practical applications of these factors. As typical for work of this magnitude, these observations continue to be central for gerontology, and are the focus of many research groups around the world. Besides marginotomy, Alexey Olovnikov also put forward a number of other hypotheses, as discussed in more detail in another memorial issue (Biochemistry (Moscow) Vol. 88, issue 11, November 2023).

In this memorial issue of *Biogerontology* we focus on different aspects of telomere and telomerase research, ranging from telomere length dynamics in wild animal populations to problems of telomere maintenance during human space flight. The articles, that have been kindly written for this special issue by leading researchers in their fields, are briefly summarized below.

The issue opens with a review about Alexey Olovnikov's marginotomy theory and the evolution of his ideas about aging, telomeres and other types of DNA termini (Olovnikov 2023). The article by Frydrychová and colleagues is an exhaustive overview of today's knowledge about the structure of telomeres, telomerase activity and telomere dynamics in different taxa of *Metazoa* (Frydrychová et al. 2023). Cordova and colleagues explore current data about telomere length maintenance and telomerase activity in germ cells and development, and how these data

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inform strategies of improving fertility (Córdova-Oriz et al. 2023). In their review, Louise Bartle and Raymund Wellinger discuss the methods used to measure telomere length, study G-tail, telomerase activity, telomerase RNA structure, and other aspects of telomere biology (Bartle and Wellinger 2023). Sharon Savage overviews different medical conditions associated with disorders of telomere biology, and highlights the importance of balanced telomere length maintenance for development and health (Savage 2023). In the review article by Chebly and colleagues, current knowledge about the role of telomere maintenance is placed in perspective of T-cell biology and their role in senescence and disease, including cancer (Chebly et al. 2023). Mélina Vaurs et al. discuss accumulating evidence that bridges two seemingly unrelated fields, connecting telomere and telomerase biology to mitochondria (Vaurs et al. 2023). Pat Monaghan analyses available data about the complex relationship between absolute telomere length, telomere loss rate and longevity within and between species, as well as practical implications of these studies (Monaghan 2024). Christopher Mason and colleagues review emerging data about the impact of space flight and microgravity on human telomeres and its practical implications for future deep space missions (Mason et al. 2024). The article by Madeline Eppard et al. discusses recent findings in telomere biology and systematizes the complex relationship between telomeres, cell stress and senescence (Eppard et al. 2023). The issue concludes with two research papers. Work by Harley and colleagues shows that neurons derived from human iPSCs with impaired telomerase activity demonstrate phenotypic and molecular features of aging (Harley et al. 2023). The paper by Lea Harrington's group utilizes a base editing approach in human cells to explore how telomere biology disorder genes can contribute to human health and aging (Borges et al. 2024).

Years 2022–2024 have witnessed great losses in biogerontology. Besides Alexey M. Olovnikov, to whom we dedicate this special issue, we would also like to honor other great gerontologists who have passed recently: George M. Martin (30 June 1927–17 December 2022), who discovered molecular mechanisms of many age-related diseases and developed important concepts in gerontology; Vladimir P. Skulachev (21 February 1935–05 February 2023), a classic in the field of bioenergetics who later moved to biogerontology, developed the concept of phenoptosis and studied the role of reactive oxygen species in aging; Calvin B. Harley (9 June 1952–8 August 2023)—a man who has been central to the discoveries in telomerase biology; and more recently Judith Campisi (12 March 1948–19 January 2024)—a pioneer and one of the leading researchers in cellular senescence. In biogerontology, like in all other sciences, we are standing on the shoulders of giants. We are grateful to have lived in the era of these giants and their discoveries.

References

Bartle L, Wellinger RJ (2023) Methods that shaped telomerase research. Biogerontology. https://doi.org/10.1007/S10522-023-10073-8

Borges G, Benslimane Y, Harrington L (2024) A CRISPR base editing approach for the functional assessment of telomere biology disorder-related genes in human health and aging. Biogerontology. https://doi.org/10.1007/s10522-024-10094-x

Chebly A, Khalil C, Kuzyk A et al (2023) T-cell lymphocytes' aging clock: telomeres, telomerase and aging. Biogerontology. https://doi.org/10.1007/S10522-023-10075-6

Córdova-Oriz I, Polonio AM, Cuadrado-Torroglosa I et al (2023) Chromosome ends and the theory of marginotomy: implications for reproduction. Biogerontology. https://doi.org/10.1007/S10522-023-10071-W

Eppard M, Passos JF, Victorelli S (2023) Telomeres, cellular senescence, and aging: past and future. Biogerontology. https://doi.org/10.1007/s10522-023-10085-4

Frydrychová RČ, Konopová B, Peska V et al (2023) Telomeres and telomerase: active but complex players in life-history decisions. Biogerontology. https://doi.org/10.1007/S10522-023-10060-Z

Harley J, Munirah Santosa M et al (2023) Telomere shortening induces aging-associated phenotypes in hiPSC-derived neurons and astrocytes. Biogerontology. https://doi.org/10.1007/S10522-023-10076-5

Mason CE, Sierra M, Feng HJ, Bailey SM (2024) Telomeres and aging—on and off the planet! Biogerontology. https://doi.org/10.1007/s10522-024-10098-7

Monaghan P (2024) Linking telomere dynamics to evolution, life history and environmental change: predictions and problems. Biogerontology. https://doi.org/10.1007/s10522-023-10081-8

Olovnikov A (1971) Principle of marginotomy in template synthesis of polynucleotides. Dokl Akad Nauk SSSR 201:1496–1499

Olovnikov AM (1973) A theory of marginotomy. The incomplete copying of template margin in enzymic synthesis of polynucleotides and biological significance of the phenomenon. J Theor Biol 41:181–190. https://doi.org/10.1016/0022-5193(73)90198-7

Olovnikov IA (2023) Alexey Olovnikov: theoretical biology beyond the margins. Biogerontology. https://doi.org/10.1007/S10522-023-10061-Y

Savage SA (2023) Telomere length and cancer risk: finding Goldilocks. Biogerontology. https://doi.org/10.1007/s10522-023-10080-9

Vaurs M, Dolu EB, Decottignies A (2023) Mitochondria and telomeres: hand in glove. Biogerontology. https://doi.org/10.1007/S10522-023-10074-7