# Subcellular Biochemistry

Volume 90

**Series editor**
J. Robin Harris
Institute of Molecular Physiology, Johannes Gutenberg University,
Mainz, Germany

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J. Robin Harris • Viktor I. Korolchuk
Editors

# Biochemistry and Cell Biology of Ageing: Part I Biomedical Science

Springer

*Editors*
J. Robin Harris
Institute of Molecular Physiology
Johannes Gutenberg University
Mainz, Germany

Viktor I. Korolchuk
Newcastle University
Newcastle upon Tyne, UK

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# Foreword: Biochemistry and Cell Biology of Ageing – Parts I and II

Never has it been more important or timely for new volumes on the science of ageing to be produced. Around the world, continuing gains in life expectancy coupled with declining fertility rates in many countries are producing profound shifts in demographic profiles. A growing fraction of the population is living to advanced old age, bringing with it increased prevalence of a wide range of age-related chronic diseases. Whereas it was once thought that ageing was something that just happened and that was relatively low on the priority list for research, recent decades have seen exciting advances in probing the complex mechanisms through which the ageing process develops.

We have come a long way from the days when it was simply assumed there was some internal biological clock that would allow us an allotted span of "threescore years and ten" and then kill us. Few had questioned why ageing should impose this fate upon us. It was loosely supposed that it was nature's way of creating living space for the next generation and securing evolutionary succession. We now know that these old-fashioned concepts have little credence. During our evolution, our genomes evolved impressive systems to try and preserve functional homeostasis in the biochemistry and cell biology of our bodies. The trouble is that there was never the evolutionary pressure to make these systems good enough completely to prevent damage from accumulating. Gradually, and at first unobtrusively, things begin to go wrong, starting from the earliest stages of life. And, it is not one thing above all others – many systems experience deterioration at the same time. Herein lies the intriguing challenge of trying to unpick the contributions of the individual mechanisms that are being found to play their part in ageing and then of putting it all together.

Understanding the biochemistry of ageing is among the most complex of problems in the life sciences. On the one hand, we need to be intensively reductionist. We need to identify the fine detail of each one of the many biochemical mechanisms that contribute to functional decline. On the other hand, we need to appreciate that knowing everything there is to know about one particular mechanism may tell us rather little about the ageing process itself. To get the bigger picture, we must acknowledge that it makes little sense to argue the case for this mechanism versus

that mechanism and so on. It is not a matter of simple alternatives. Instead of rooting for mechanism A *or* B *or* … *or* Z, we must learn to appreciate that it is A *and* B *and* … *and* Z. Whether we call this integrative biology, or systems biology, or some other term of a similar nature, the bottom line is that we need to join forces and learn as much as we can about the different biochemical mechanisms and their often synergistic interactions. In some ways, the science of ageing is the science of life itself. In the traditional school of biochemistry, we learn about how life has evolved the remarkable processes of DNA replication, transcription, translation, turnover, signal transduction, cell division, and all the rest. These systems are so beautifully coordinated that we might marvel at first at how well they work. But the underlying molecular interactions are noisy and subject to perturbations of all kinds and at all times. It is this reverse side of the orderliness of biochemical processes that we need to appreciate to understand ageing.

In clinical terms, ageing is equally complex and challenging. Age is much the largest risk factor for a whole spectrum of different diseases, dwarfing the contributions from genetic, lifestyle, and environmental risk factors. Furthermore, the fact that so many conditions share ageing as their dominant risk factor means it is no surprise that very old people commonly exhibit extensive multi-morbidity. But is ageing normal, or is it a disease? The answer is that ageing is a normal biological process but it has the distinctive property that it makes us more vulnerable to diseases of many kinds. So, it is a bit of a hybrid – both normal and also the source of pathologies. The old arguments about whether ageing is normal or disease are not particularly helpful. Ageing is driven by the accumulation of damage in our cells and organs, and the same is true of age-related, chronic diseases. Thus, there is a huge overlap. Once we understand the basic mechanisms of ageing itself, we will gain valuable knowledge about the many diseases which may affect us in later life. Thus, the study of the biochemistry and cell biology of ageing should seek to combine biomedical and clinical science. It is to be warmly welcomed, therefore, that J. Robin Harris and Viktor Korolchuk have produced these twin volumes, bringing into intimate juxtaposition a collection of state-of-the-art reviews of the biochemistry of ageing from both perspectives.

Emeritus Professor, Newcastle University Thomas B. L. Kirkwood
Institute for Ageing, Newcastle upon Tyne, UK

# Preface

This book, *Biochemistry and Cell Biology of Ageing: Part I, Biomedical Science* (along with Part II, Clinical Science), was conceived following the reading (by JRH) of Lewis Wolpert's controversial yet thoroughly enjoyable 2011 book *You're Looking Very Well: The Surprising Nature of Getting Old*. As a broad discipline, *Ageing* has been deemed to fit in well with the diverse content of the Springer *Subcellular Biochemistry* series, and the two books covering Biomedical Science and Clinical Science were duly commissioned.

We have attempted to compile a list of chapters written by authoritative authors to cover the field as thoroughly as possible. Along the way to production, a few chapters failed to appear! Nevertheless, the remaining 17 chapters provide a good coverage of the subject. To place the available chapters in a logical sequence has defeated us; we have simply presented them here as they appear in our initial list of agreed chapters, at the time of compilation. Each Biological Science chapter stands firmly on its own merit, with correlation to the Clinical Science book chapters in some cases. Over recent decades, ageing research has expanded enormously worldwide, responding to the increased importance to the general population, where there is an obvious desire to retain "quality of life," health, and self-sufficiency into the later years.

The Contents list page, immediately following this Preface, shows the range of topics that are included. Without singling out any individual topic and author(s), it is clear that most of the important aspects of ageing research are included. Together they provide an in-depth survey of fundamental biomedical science within the field of ageing research. We hope that the book will be of value to undergraduate biomedical science students, medical students, postgraduate researchers, and academics involved and interested in aspects of ageing research.

Johannes Gutenberg University
Mainz, Germany
J. Robin Harris

Newcastle University
Newcastle upon Tyne, UK
Viktor Korolchuk

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# Contents