IJMR Indian Journal of Medical Research

Indian J Med Res. 2015 Dec; 142(6): 776–777. PMCID: PMC4774080

Aging and health - A systems biology perspective

Reviewed by Chiranjib Chakraborty

A.I. Yashin, S.M. Jazwinski, editors. 2015. Karger: Basel, Switzerland. 194. US$212.00 / CHF 180.00. ISBN 978-3-318-02729-7.

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Systems biology is presently a field of interest for computational biologists to collect comprehensive biological datasets to gain information about the constituent molecules. With the help of this subject, one can solve problems of compound biological regulatory systems as this field can offer knowledge and new opportunities for practical application natural science.

This book provides valuable information on ageing and health-related issues, not only for basic ageing researchers, but also for health care professionals who are inclined to learn more about the role of systems biology in ageing and health. The book includes an introduction and 13 chapters with 36 figures and nine tables. In each section, leading experts have shared their scientific knowledge about their field of expertise related to ageing, covering a broad range of topics such as ageing networks, modulating mTOR, diet-microbiota-health, *etc*. In every chapter, the authors entail the reader on a journey through the current advances in ageing with a cover image that represents nutshell of the core topic.

The “Introduction” provides a background of systems biology, its importance in the field of biology as well as a brief description of each chapter contributed by different authors. The first chapter entitled “Introduction to the Theory of Aging Networks” describes systems biology and its use in the perceptison of the dynamics of ageing using network mathematics. The chapter starts with a history of network analysis and ends with possible genes and protein systems that control an organism's life span using graph theory.

The second chapter, “Applications to Aging Networks”, includes additional network concepts and applications of the systems biology of ageing. These concepts and models have been used on two model organisms namely, *Saccharomyces cerevisiae* and *Caenorhabditis elegans*.

In the third chapter, “Computational Systems Biology for Aging Research”, study of the ageing process is discussed through the dynamic computational modelling using differential equations. It also describes how different computational models can illustrate complicated age-related disorders allied with unhealthy ageing using this platform.

Chapter 4 entitled “How Does the Body Know How Old It Is? Introducing the Epigenetic Clock Hypothesis” starts with biological clocks which assist in controlling circadian cycles, seasonal rhythms and other normal processes such as growth, development, sexual development, *etc*. in both animals and

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plants. A number of ageing clocks have been projected in this section such as cellular senescence suprachiasmatic nucleus, involution of the thymus, the hypothalamus, *etc*. Finally, the author suggests a novel epigenetics based candidate for an ageing clock, which is the state of chromosome methylation especially in stem cells. However, this hypothesis needs to be validated.

In the fifth chapter, “The Great Evolutionary Divide: Two Genomic Systems Biologies of Ageing” the authors describe two different types ageing in species. This section also provides an evolutionary argument that ageing in various species with frequent sexual recombination is moderately diverse. One type of systems biology of ageing spotlights the effects on mutants, transgenic, combinations, *etc*. The patterns of ageing related to genome-wide effects, as well as genetic drift on the abundant polymorphic loci have also been commented on.

The sixth chapter entitled “Development and Ageing: Two Opposite but Complementary Phenomena” discusses two different and corresponding aspects of ageing. To compare from the evolutionary point of view, several systems biology techniques to represent ageing-related networks for human and murine models have been used. Finally, validation of the DevAge molecular model has also been dealt with.

An individual's health deficits accumulate during the life span and may be reflected in ageing, which is discussed in the chapter entitled “Aging as a Process of Deficit Accumulation: Its Utility and Origin”. Here, the frailty index which is related to the biological age of the individual. A stochastic dynamics framework has been applied to model the standard recovery time that expands with age.

The eighth chapter entitled “Low-Grade Systemic Inflammation Connects Aging, Metabolic Syndrome and Cardiovascular Disease” describes the connection of ageing with metabolic syndrome like diabetes and cardiovascular disease and its constant association with inflammatory conditions. The mechanistic target of rapamycin (mTOR), of the PI3K family, is extensively discussed for nutrient response pathway and is also shown to modulate the ageing process. The next chapter entitled “Modulating mTOR in Aging and Health” discusses the ageing process in evolutionarily different organisms as the mTOR activity is thought to prolong the life process from lower to higher organisms like yeast to rodents. Presently, scientists are studying the clinically accepted mTOR complexes and related signaling network which, may provide new promises for interference in human ageing and age-related diseases through the modulation of a particular pathway.

Chapter 10 entitled “Melatonin and Circadian Oscillators in Aging - A Dynamic Approach to the Multiply Connected Players” describes melatonin and its relation to ageing from the systems biology point of view. This hormone plays a vital role in modulating the mitochondrial electron flux, the redox balance as well as inhibits unnecessary free radical development. It also controls the essential circadian clocks and is necessary for high-amplitude rhythms. This chapter also discusses the association of the failure of melatonin release and rhythms to aging and age-related disease.

The subsequent chapter, “Diet-Microbiota-Health Interactions in Older Subjects: Implications for Healthy Aging” suggests that with the help of a healthy lifestyle and modern medicine, people can live longer. The chapter also relates the adult microbial population correlates, markers of inflammation and co-morbidity as well as the nutritional status and finally concludes with the significance of the microbial population and related metabolites in a healthy ageing process with the importance of diet modulation.

In chapter 12, entitled “Systems Biology Approaches in Aging Research”, systems biological advancements have been discussed. Features of the chief methodology such as refined mathematical and computational tools, mathematical modelling and data sets, *etc* have been detailed. It has been suggested that the present systems biological methods from other research fields can be worked out for new ageing-specific systems biological research methodology.

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The last chapter provides an investigational proof for rapamycin on survival and carcinogenesis in the mouse model. It shows that rapamycin is a molecule for pharmacological intervention that can necessitate life period expansion and cancer deterrence.

In conclusion, the editors have succesed in bringing new systems biology perspectives to clinicians and basic scientists working in ageing and health research. Although seemingly aimed at ageing scientists and systems biology experts, this book should be read by everyone, especially those who work in clinical segments.

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