

Preface

This book is dedicated to the great scientist and outstanding person Nikolay Wladimirovich Timofeeff-Ressovsky. Since his death 30 years have passed, but his scientific research as well as his life attract people, though there are conflicting opinions. We all appreciate his huge contribution to the science. However, Nikolay Wladimirovich himself valued human qualities more than the talents of man (“the main thing that was a good man”).² He found the personality of man and his life on the first place. His inner freedom came herein and was manifested in all situations including the Nazi Germany, the prison and camps of the USSR. The scientific discoveries of Timofeeff-Ressovsky are the bases for later studies, and his personality will always be relevant.

To acquaint you with Nikolay Wladimirovich, we have included a few excerpts from his stories,³ essays of persons who knew him closely, and brief papers of investigators of his life. You can find this material in Part I.

Extensive scientific research of Timofeeff-Ressovsky covered several areas. In 1935 his studies were devoted to the structure of genetic material⁴; his later works: the hit principle,⁵ evolution,⁶ radiation biogeocenology,⁷ and finally, the paper

²Private memories of Vladimir I. Korogodin (eds).

³Timofeeff-Ressovsky NV (2000) The Stories Told by Himself with Letters, Photos and Documents. Dubrovina N. (ed) Soglasie, Moscow (Russian).

⁴Timofeeff-Ressovsky NW, Zimmer KG, Delbrück M. (1935) Über die Natur der Genmutation und der Genstruktur, Nachrichten von der Gesellschaft der Wissenschaften zu Göttingen: Math.-Physik. Klasse, Fachgruppe VI, Biol Bd. 1(13): 189–245 (German).

⁵Timofeev-Ressovsky NW, Zimmer KG (1947) Das Trefferprinzip in der Biologie. Biophysik Bd 1 (Hirzel, 1947) (German).

⁶Timofeeff-Ressovsky NW (1939) Genetik und Evolution (Bericht eines Zoologen). J Mol Gener Genet 76(1): 158–219 (German).

⁷Timofeeff-Ressovsky NW (1962) Some problems of radiation biogeocenology. Dr Sci. Thesis, Sverdlovsk (Russian).

“Biosphere and Humanity”⁸ have showed his worldview. The next parts include the chapters on the main scientific directions of Timofeeff-Ressovsky: genetics, radiobiology, radiation ecology and epidemiology, and evolution.

In the “Genetic Processes” (Part II), S.G. Inge-Vechtomov analyzed the template principle in connection with central dogma of molecular biology. Evolution and expansion of genetic paradigm proceeded from Mendelism to chromosome theory and further to the concept of DNA as genetic material is presented. Replication, transcription, translation as the first-order template processes (TP I) operating with the linear templates with their universal characteristics (ambiguity and repair, or correction) are considered along with the second-order template processes (TP II), operating with spatial, or conformational protein templates. The attention to the former ones had been stimulated at the end of twentieth century by the study of prions and amyloids. Comparative characteristics of the TP I and TP II and of their interaction are discussed.

At present the protein-based inheritance and mutation rate are mainstream topics in genetic studies. Many scientists have puzzled over the mutation rate for a long time. In eukaryotic genome, it depends on some factors: nucleotides pools, conditions of replication, types of DNA damage and its repair, structure of chromatin. In this part the mechanisms of global and region-specific control of mutagenesis are presented and discussed by Y.I. Pavlov and his colleagues. But the most interesting question is “why four major groups of organisms have their own characteristic rates of spontaneous mutation?” It is clear that the evolutionary forces drive these characteristic rates. J.W. Drake discussed this mystery. The protein-based inheritance and protein assemble disorders are reviewed by A.A. Rubel with his colleagues. The authors considered the prion concept, models describing the replication and transport of prions particles, structural features and functions of the cellular PrP, the prion strain phenomenon, current developments in diagnostics of prion and potential antiprion therapies. Recent advances in wheat improvement via alien gene transfer and gene duplications are reviewed by V.K. Shumny, E.K. Khlestkina et al. with emphasis on disease resistance and new functional specialization.

In the “Radiobiology Effects and Mechanisms” (Part III), C. Mothersill and C. Seymour present evolution of radiobiological thought; they give retro- and prospective scheme of radiobiological research directions. Their chapter aims to trace the evolution of the major ideas in radiobiology from the earliest speculations about how the new rays are related to mutations, to the understanding of the relevance of indirect effects, non-targeted effects and the role of epigenetics. The authors predict shift from reductionism to a more holistic approach; it means, for example, taking into account the phenomena of adaptive response in medicine, and interactions of multiple stressors in radiation ecology.

Using a stochastic approach, V. Korogodina et al. showed that the same adaptation mechanisms of the prolonged impact and chronic exposure of plants, animals,

⁸Timofeeff-Resovsky NW (1967) Biosphere and Humanity. Proc. Geography Society USSR, Obninsk: 3–12 (Russian).

or humans lead to the essentially different effects in the populations. Radiation stress changes parameters of reproduction aimed to increase population diversity; chronic prolongation produces progressive selection of a group of the resistant objects. The chapters of O.V. Belov, A.N. Bugay and their colleagues are devoted to an analysis of the mutation processes and DNA damage repair which involve many molecular events, pathways and different genes. In their chapter, H. Abel and G. Erzgraeber noted that the “linear no-threshold hypothesis” cannot be interpreted in the sense of a dose-linear increase of all cancer-induction processes in the range of the natural ionizing radiations. B.P. Surinov considered the role of chemosignaling in the realization of the bystander effect during communications between irradiated and intact animals in mice population.

Parts IV and V are devoted to “Radiation in Ecological Systems” and “Radiation and Man”. Nowadays radionuclide contamination and use of nuclear energy are widespread, and the low-dose radiation effects are extensively studied. Part IV reflects a process of data accumulation and their continued discussions.

In his chapter, President of the International Union of Radioecology (IUR) F. Brechignac stressed that assessing ecological radiation risk requires an ecosystem approach. The ecosystem approach provides a conceptual vision which integrates humans within the environment. Historically, the issue of “protection of the environment” against radiation was more bound to human health than associated with wildlife and ecosystems. Protection of the environment includes living beings and abiotic media, landscapes and ecosystems. It prevents interactions between populations of different species and other indirect cascade biological effects; that is holistic goal of protection.

Accident process, radioactivity release and ground contamination are described by T. Imanaka, who compared the radiation characteristics of the Fukushima-1 and the Chernobyl disasters in his chapter. S.A. Geras'kin et al. described radiation effects on ecosystems: changes in species dominance, reduction in productivity and changes in a community structure. The studies of T.A. Mousseau and A.P. Møller are devoted to the animals of Chernobyl and Fukushima. The authors observed the parallels between radiation effects on animals in Chernobyl and Fukushima that provide additional evidence for the significant ecological consequences of nuclear accidents, and ionizing radiation in general. There are chapters which present the radiation effects on the terrestrial (D.M. Grodzinsky, E.V. Antonova et al.) and aquatic ecosystems (D.I. Gudkov et al, S.B. Gulin and V.N. Egorov); influence of Nuclear Power Plant fallouts on soil bacteria is analyzed by G.E. Khachatryan et al. The methods of radioecology approach and models of radiation risks assessment are offered by Y.A. Kutlakhmedov et al., A.A. Cigna, S.B. Gulin and V.N. Egorov.

Part V includes research on radiation influence on humans. C. Mothersill and C. Seymour presented the fundamental concepts of radiobiology: the authors offered mechanisms of sick health and chronic fatigue syndrome suffered by atomic and gulf war veterans. Review on Chernobyl consequences for humans and evaluation of genetic radiation risks are given by I. Schmitz-Feuerhake and S. Pflugbeil; A.V. Yablokov devoted his chapter to fundamental difficulties of dose calculation. M. Rosemann described radiation-induced aging and genetic instability of

mesenchymal stem cells. Despite a small number of adult stem cells in an organism, they play an important role for the long-term functionality of all organs and hence, for a healthy aging process. It has been shown that acute or chronic radiation exposure to adult stem cells can impair their genetic stability and have late health effects in various organs. I.E. Vorobtsova and A. Semenov discussed the cytogenetic effects of low-dose irradiation of people. This subsection includes the data on cancer therapy too (I.A. Zamulaeva et al.).

In Part VI (“Laws of Evolution”) some systems of different levels of organization are presented, but the genetic evolution of genome was used as a basis of our brief review. Eu. V. Koonin presented analysis of the collection of genome sequences from diverse bacteria, archaea, eukaryotes and viruses and his design of the “genomic universe” on the basis of features of genes. Contrary to the evolutionary stability of some genes, the genomes are dynamic on the evolutionary scale. The author demonstrates a highly dynamic picture of the evolution of the genomic universe dominated by horizontal gene transfer; but a “statistical Tree of Life” can be a strong sign of vertical evolution.

The processes of evolutionary changes are described in some chapters devoted to plant–microbe symbiotic interactions (I.A. Tikhonovich et al.), the animal domestication as an example of targeting regulatory system (N.A. Kolchanov with coworkers), and coevolution of human endogenous retroviruses with our genome (A.A. Buzdin et al.). The role of central nervous system of mammals as a mutagenic/anti-mutagenic factor is described by E.V. Daev.

We included the essay of Russian ethologist Prof. Eu. N. Panov “Roots of current concepts in the studies of social behavior in animals”. He discussed the history of zoosociology development in the period from the late nineteenth century up to the 1970s. The goal was to show the principles of organization operating in the local animal populations that are considered as social organisms of complex systemic nature.

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