REVIEWS

Natural Atomic Radiation and the Phenomenon of Life

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Experimental studies are discussed which lead to discovery of secondary biogenic radiation emitted by living tissues after their γ-irradiation in doses far lower than lethal ones.

Key Words: *natural background radiation; secondary biogenic radiation; radiation hormesis*

Studies over a period of more than two decades, together with analysis of the literature, led us to several conclusions that interpret in a new light the significance of natural atomic radiation for the phenomenon of life on the Earth. A brief review of these conclusions is presented below.

The entire biosphere of the Earth is filled with high-energy quanta of atomic radiation that are continuously generated by radionuclides constantly formed due to cosmic radiation fluxes and dispersed in small amounts in rocks, water, and atmosphere [3,5].

There is no living organism that is not constantly exposed to a low-level atomic radiation which constitutes natural background radiation (NBR) of the Earth.

It has been demonstrated that the major vital processes, such as cell division and growth and development of the body, are significantly, though slightly, inhibited in protozoans [25,26], higher plants [8], and animals [11,12] screened from the external NBR. Experiments with protozoans [24], higher plants [13], and animals [9] showed that these processes become strongly inhibited when such screening is combined with a reduction in the internal body radiation due to removal of ^{40}K from dietary potassium.

From these findings it can be concluded that NBR is an invariable and essential component of life. In other words, there can be no life without exposure to atomic radiation at naturally occurring levels.

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It has been reported that long-term exposure to NBR elevated by 1 or 2 orders of magnitude or short-term exposure to low doses of atomic radiation (2-3 orders of magnitude lower than the damaging dose) activates the major vital processes (a phenomenon called radiation hormesis) [4,6,23], which is consistent with the conclusion that atomic radiation at the NBR level is necessary for life.

In a living organism atomic radiation causes molecular ionization and excitation. The well-known damaging effects of atomic radiation on the biota are due to ionization, as it was proved in the 1940s [21], while the influence of excitation is negligibly small. However, only relatively high doses of radiation (more than five orders of magnitude higher than NBR) cause damage. In an attempt to answer the question why NBR is essential for life, we have studied radiation-induced excitation of molecules characteristic of living organisms, namely, proteins and nucleic acids [5]. We emphasize the need for studying this process not in isolated molecules but *in vivo*, where these molecules are endowed with oscillatory kinetic energy [7].

As shown by Li [22] and Popp [27] on the basis of the general theory of excitation developed by Dicke [17,18], excitation of condensed DNA in the cell by ultraviolet (UV) radiation results in delocalization of excited electrons from the initially excited bases in DNA, their accumulation in the macromolecule, and interaction with its oscillatory kinetic energy to form long-lived (existing for several hours) vertical clusters referred to as "polaritons". Subsequent disintegration

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of these polaritons causes DNA to emit coherent radiation of a much larger wavelength than that of the radiation which has elicited the excitation. It was demonstrated that the radiation emitted by DNA is in the visible region of the spectrum [28].

Proceeding from these results, we have suggested [7] that exposure of living systems to high-energy atomic radiation results in the formation of polaritons in proteins and nucleic acids, and disintegration of polaritons induces a secondary coherent radiation in the UV region in these systems. We have hypothesized that this secondary radiation (low intensity, coherence, and UV range) is analogous to the mitogenic rays discovered in the 1930s [1], i.e., it is biologically active (stimulates cell division).

In 1994 we reported [14] that after stimulation with a low-dose γ-radiation living plant structures (seeds and lilac branches with buds in a state of profound quiescence in winter) or yeast masses are capable of stimulating the development of a germinating seed or opening bud at a distance.

From these findings we concluded that exposure of plant tissues to low-dose atomic radiation induces secondary radiation which stimulates the division of resting undamaged cells. We designated this radiation as secondary biogenic radiation [20].

We have recently shown that secondary biogenic radiation is intensely emitted by native condensed protein of a living hen's egg after exposure to γ-radiation in a dose of 0.2-10 Gy [15]. This was not observed in case of heat-coagulated protein. A very weak secondary biogenic radiation is emitted by native protein from hen's egg without exposure to γ-radiation, presumably as a result of continuous exposure to NBR [15].

We have further demonstrated that secondary biogenic radiation is also emitted by living animal tissues (insect bodies, freshly cut animal and human hair, and surviving liver tissue) following exposure to low-dose γ-radiation. No radiation was emitted by heat-killed animal tissues [15].

As shown previously [10,16,19], stimulation by low-dose atomic radiation is always accompanied by activation of membrane receptors. Therefore, it was suggested that receptor molecules are directly activated by radiation. However, the discovery of secondary biogenic radiation makes it reasonable to suggest that this radiation carries the information that is received by membrane receptors and is necessary for functioning and development of a living organism.

On the basis of the reviewed data the following concept of the role of natural atomic radiation in the phenomenon of life can be formulated.

Atomic radiation permeates the entire biosphere. All living organisms are continuously exposed to NBR. The intensity of this radiation is so low that molecular ionization does not impair normal development of a living organisms due to operation of the mechanisms responsible for restoration and regeneration of tissues and elimination of ionized molecules. The bulk of cells remain in the native state. The concurrent excitation of condensed biomacromolecules generates a secondary biogenic coherent radiation.

Secondary biogenic radiation permeates all cells and tissues and after being emitted acts on nearby living organisms. This radiation, which pervades all biota, carries to membrane receptors the bioinformation essential for the existence of an organism as a single whole. It probably constitutes the physical basis of the biofield present in living organisms [2].

Thus, based on the above-mentioned findings, the data of molecular biology, and the role that information plays in a living organism [27], the phenomenon of life can be defined as a process mediated by a hierarchy of open systems composed of carbon-based macropolymers residing in an aqueous medium in a condensed, structurized, stable, and nonequilibrium state excited due to continuous exposure to NBR. This is a process that occurs under the influence of biofield formed by secondary biogenic radiation and ensures the existence, self-reproduction, and development of these systems, utilizing material resources and energy of the environment and various information flows, including the information contained in the secondary biogenic radiation.

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