

Global Congress on

Nucleic Acids: Biology, Health & Diseases

August 04-05, 2016 New Orleans, USA



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Origin of biological nucleic acids and the first genetic system (the progene hypothesis)

Biological nucleic acids perform some well-known fundamental functions like: template; coding of polypeptides; transport of activated specific amino acids; enzymatic (ribozymes); regulating (small RNAs) and structural (ribosomes, chromosomes, virions). The most accepted concept of the origin of nucleic acids and life is the RNA world hypothesis which is supported by many scientists. It is suggested that the first polynucleotides are synthesized spontaneously from mononucleotides on prebiotic Earth. According to the RNA world hypothesis, the first living beings (protoorganisms) consisted of RNA with both the template and the enzymatic functions, without any proteins; the translation process and the genetic code appeared later in evolution. There are very strong objections against the RNA world hypothesis: 1) The emergence of the first protoorganism is impossible without a processive (moving along template) polynucleotide polymerase; at present only distributive polymerases out of nucleotides were obtained; processive polymerases of such nature are unknown and apparently cannot exist in principle. 2) Synthesis of long polynucleotides from racemic mixture of different prebiotic mononucleotides is impossible without stereospecific catalysts. 3) Within frames of the RNA world there is no clear understanding of mechanism of genetic code and translation arising. In order to overcome these obstacles and to explain how the first biological nucleic acid (the first gene) arises simultaneously with a specific protein (a processive polymerase) forming a bimolecular genetic system (BMGS), I have proposed an alternative hypothesis (the progene hypothesis) (Altstein, 2015). According to this hypothesis, BMGS emerges not from mononucleotides and monoamino acids, but from progenes, namely, trinucleotides aminoacylated on 3'-end by a non-random amino acid ($NpNpNp\sim pX\sim Aa$, where N - deoxyribo- or ribonucleoside, P - phosphate, X - a bifunctional agent, for example ribose, Aa - amino acid, \sim macroerg bond). The progenes are used as the only substrates for interconnected synthesis of a polynucleotide and a polypeptide. The growth of the system "polynucleotide - polypeptide" is controlled by the enzymatic properties of the growing polypeptide, and the BMGS emerges as an extremely rare event. The progene forming mechanism ($NpNp+Np\sim pX\sim Aa$) makes it possible to explain the emergence of the prebiotic physicochemical group genetic code, as well as the selection of organic compounds for the future genetic system from the racemic heterogeneous environment. The BMGS is reproduced on a progene basis via replicative transcription-translation (the first molecular genetic process) that is similar to its modern counterparts. Nothing is required for the emergence and reproduction of the BMGS except for progenes and conditions for their formation, including lipid vesicles and short oligonucleotides (2-6 nb).

Biography

Anatoly D. Altstein is a Virologist. He studied problems of viral carcinogenesis, development of viral vaccines, biotechnology and origin of genetic mechanisms. Now, he is a Main Scientist of Institute of Gene Biology and N F Gamaleya Federal Scientific Center of Epidemiology and Microbiology and also Professor of I.M. Sechenov 1st Moscow State Medical University. He has published more than 100 papers in international and Russian journals and has been serving as an Editorial Board Member of the "Molecular Genetics, Microbiology and Virology" journal (Moscow, Russia).

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