International Conference

THE PROBLEM OF THE ORIGIN OF LIFE

and

Youth Scientific School

MOLECULAR AND CELLULAR BASIS OF THE EARLY EVOLUTION OF LIFE

BOOK OF ABSTRACTS

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ORIGIN OF LIFE ON EARTH: CURRENT MODELS

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Origin of life remains one of the most difficult and intriguing problems in life sciences. Ever since Louis Pasteur disproved spontaneous generation, scientists have been struggling to find plausible scenarios of gradual prebiotic evolution. Over the last few decades, major advances have been achieved in understanding how the gap between inanimate matter and the first life forms could have been filled. Important insights are coming from inorganic chemistry (e.g., plausible ways of abiogenic synthesis of key organic compounds have been found), biochemistry, molecular biology and comparative genomics (e.g., theory of RNA world; models of evolution of protein synthesis and ribosomes; reconstructions of gene content of LUCA, etc.) and other disciplines. In line with A.I.Oparin's ideas, artificial 'protocells' with lipid membranes have been designed, capable of growth, division, and even, to a limited extent, non-enzymatic DNA and RNA replication. Overall, most major gaps are being gradually filled, so that estimates of probability of origin of life on an Earth-type planet tend to grow, thus increasing our chances to find life elsewhere in the Universe.

FOUR FUNDAMENTAL PHYSICAL PROPERTIES OF THE LIVING CELL AND THE PROBLEM OF LIFE ORIGIN

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Methodology of decision problem of the origin of life is determined by our perception of the fundamental physical properties of the living cell. These include: (1) selective permeability (or semipermeability), (2) ability to selectively accumulate and exclude solutes, (3) ability to maintain osmotic stability, and (4) ability to generate electric potentials.

Currently, it is generally accepted that plasma membrane is the carrier of these properties. In this case, the problem of the origin of life is reduced to the problem of the origin of the membrane with all components without which the life of the cell is not possible: lipids, channels, carriers and pumps. However, domestic and foreign literature present the dramatically different approach: the fundamental physical properties of the cell are determined by sorption properties of proteins. According to the unified sorption physical theory of the living cell, origin of proteins is a key event in the origin of life. Origin of proteins, in contrast to origin of functional membrane, became the object of experimental studies about 80 years ago, and more—proteins only (without lipids) produce protocell models demonstrating many features of the living cell including electrical activity (coacervates, microspheres).

Sorption properties of proteins with fully-extended chain include capacity to adsorb water, ions, small organic solvents and proteins on its molecular surface. Thickness of the adsorbed layer of water can reach millions of molecular layers. Adsorbed water is poor solvent and serves as a barrier for diffusion (the property #1). The poor solvent excludes solutes in bulk water with better solvent properties (the property #2). Dicarboxylic acids selectively bind K+ ions in the presence of Na+ (the property #1, 2). Certain regions of a polypeptide chain can (or cannot) bind small organic solvents (the property #1, 2). Ability of proteins with fully-extended chain to bind water explain the property #3. Ability of proteins localized at interfaces (in particular, at cell surface) selectively adsorb ions explains bioelectric phenomena (the property #4). Since first proteins had qualitatively the same properties as modern ones the sorption theory of protocell origin is completely based on known physical principles and available experimental data and did not need in lipids and functional membranes as the first "living" structure. Evolution mechanism improved qualitatively and quantitatively the four fundamental properties of the living matter but essence of the properties remained unchanged. The presentation focuses on physical foundations of sorption approach to the origin of life.

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