PUZZLES OF BIOCHEMISTRY OF EXTRATERRESTRIAL LIFE. Tairo Oshima, Institute of Environmental Microbiology, Kyowa-kako Co., Machida, Tokyo 194-0035, Japan; tairo.oshima@kyowa-kako.co.jp

Biochemical Exclusion Principle: Chemical structures of biological molecules are strictly restricted by "biological exclusion principles". The author would like to discuss whether or not the exclusion principle can also be applied on biochemistry and molecular biology of extraterrestrial life.

Magic 20: Amino acids incorporated into proteins during translation processes are limited to 20 amino acids. This set of amino acids is often called "magic 20" (This term is originally used by Crick in the late 50'). Proteins in terrestrial organisms consist of many different amino acids in addition to the members of magic 20 due to post translational modifications (one example is hydroxyproline residues in collagens which were converted form proline residues by post translational modifications), and in exceptional cases other amino acids than the members of magic 20 are directly coded by mRNA; one example is selenosystein in formate dehydrogenase. When, how and why the members of magic 20 are selected is fundamental enigma. Members of magic 20 are alpha-amino acids; gamma aminobutyric acid is an important amino acid in brain function, but not the member of magic 20. Amino acids which possess straight hydrocarbon chain, such as normal-leucine are excluded, but no rational explanation has been presented so far. It seems that the members of magic 20 are determined by chance or impulse or whim rather than by necessity or reason. Functional protein can be produced omitting some amino acids from magic 20; one example is proteins produced by aerobic thermophiles. Often enzyme proteins produced by extreme thermophiles lack cystein (a member of magic 20) since cystein residue is unstable under high temperatures. Extraterrestrial organisms may use a different set of amino acids to make proteins.

Nucleic Acids: Our DNA and RNA consist of D-ribose (or its derivatives), four nucleic acid bases and phosphate. Again no rational explanations have been given for fundamental questions such as why ribose and phosphate are chosen. Why 4 bases? As a coding language, binary system may be better than quaternary like in our computers. Extraterrestrial life may use binary as genetic language. It seems that the most rational genetic system is binary consisting of adenosine and inosine; This idea was also proposed by Crick long time ago.

Chirality: The members of magic 20 are L-amino acids, and deoxyribose used in DNA and ribose used in RNA are D-sugars. Origin of the chirality of biological molecules is another fundamental enigma in biochemistry of terrestrial life. In this context, another serious puzzle is chirality of membrane lipids; glycerol moiety of major membrane lipids of domain Archaea is d-form whereas Bacteria and Eukarya use l-form glycerol residues.