EXPOSURE OF AMINO ACIDS AND THEIR PRECURSORS TO SPACE IN THE TANPOPO MISSION: THE FIRST JAPANESE ASTROBIOLOGY EXPERIMENTS IN LOW EARTH ORBIT. K. Kobayashi[1], H. Mita[2], Y. Kebukawa[1], K. Nakagawa[3], H. Yabuta[4], E. Imai[5], H. Yano[6], H. Hashimoto[6], Y. Kawaguchi[6], S. Yokobori[7], A. Yamagishi[7], and the TANPOPO WG[6], [1]Yokohama National University (Chemistry Department, 79-5 Tokiwadai, Hodogaya-ku, Yokohama 240-8501, Japan; kkensei@ynu.ac.jp), [2]Fukuoka Institute of Technology, [3]Kobe University, [4]Osaka University, [5]Nagaoka University of Technology, [6]JAXA/Institute of Space and Astronautical Science, [7]Tokyo University of Pharmacy and Life Science.

Introduction: It has been reported that a wide variety of organic compounds are present in extraterrestrial bodies such as carbonaceous chondrites (CCs) and comet, and their relevance to the origins of life is widely discussed. These extraterrestrial organics could have been delivered to primitive Earth by meteorites and comets. Chyba and Sagan [1] suggested, however, that more organic materials were delivered to the Earth by interplanetary dust particles (IDPs) rather than by meteorites or comets. Since most IDPs have been collected in terrestrial environments such as ocean sediments, Antarctic ices, and air in stratosphere, presence of pristine amino acids has not been confirmed. Stability of IDP organics is another question because IDPs are so tiny that they are to be fully exposed to solar UV and cosmic radiation. Thus it is of interest to examine whether IDPs could carry bioorganics such as amino acids to the terrestrial environment.

We will start a novel astrobiology mission named *Tanpopo* by utilizing the Exposed Facility of Japan Experimental Module (JEM/EF) of the International Space Station (ISS) [2, 3]. The Tanpopo Mission includes the capture experiment and the exposure experiment. In the capture experiment, we will collect dusts (including IDPs and dusts of terrestrial origin) on the ISS by using a newly developed extra-low density aerogel (density: 0.01 g cm^{-3}) [4], since both dusts in space and ISS are moving at 8 km s^{-1} or over. In the present paper, exposure of organic compounds in the Tanpopo Mission will be introduced.

Target Molecules for the Exposure Experiment: In the exposure experiments, five kinds of amino acids or amino acid precursors were selected. A number of amino acids were detected in water extract of CCs, but it is controversial whether major part of amino acids in CCs present as free amino acids or amino acid precursors (or bounded amino acids). Glycine, the simplest amino acid, is one of the most abundant amino acids found in CCs. Isovaline is one of the α-methyl amino acids whose relatively large enantiomeric excesses were reported [5]. There are many candidates for the precursors of amino acids, but here we chose hydantoin and 5-ethyl-5-methyl hydantoin as possible amino acid precursors since hydantoin has been identified in CCs. We also added complex amino acid precursors synthesized by proton irradiation of a mixture of CO, NH_3 and H_2O (hereafter referred to as CAW): CAW contained high molecular weight precursors of amino acids [6].

Exposure Apparatus for the Tanpopo Mission: An apparatus for exposure experiments was a rectangular solid of 100 mm × 100 mm × 20 mm. It was divided into 20 independent chambers, and a round aluminum plate (18 mm in diameter) having 19 small holes (1.5 mm in diameter) was set in each chamber. An MgF_2 or quartz window of 16 mm in diameter was attached at the top of each chamber, and a filter of 0.3 mm was set at the bottom. Aqueous solution of the amino acid or their precursor was added into holes, was dried, and was covered with thin hexatriacontane layer. Total dose during exposure will be monitored by a newly developed alanine film dosimator, based on the fact that decomposition rate of alanine correlated to radiation dose [7].

The apparatus will be attached to the ExHAM facility on JEM/EF on ISS. Exposure will last for one to three years, and the apparatus will be return to the Earth.

Ground Simulation: The selected molecules were irradiated to high-energy heavy ions, γ-rays, or VUV (172 nm) to evaluate their stability in space. It was proved that amino acid precursors were much more stable than free amino acids [8]. These results, together with the fact that complex precursors of amino acids could be easily formed from possible interstellar media, suggested that not free amino acids but amino acid precursors could have been delivered by IDPs in prior to the generation of the first terrestrial life.

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