Overview of Kibo experiment candidates for around 2012

1. Experiment Title

Effect of space environment on mammalian reproduction

2. Principal Investigator

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3. Outline of Experiment

Sustaining life beyond Earth either on space stations or other planets will require a clear understanding of how the environment in space affects key phases of mammalian reproduction. Recently, we studied mammalian fertilization and preimplantation development under microgravity (μG) conditions using a three-dimensional (3D) clinostat, which closely simulates a 10–3 G environment using 3D rotation. Although fertilization occurred normally in vitro under μG, the offspring birth rate was significantly lower than the 1G controls due to the poor development of placental cells. This suggests that mammalian species may have difficulty reproducing in space, and highlights the importance of performing experiments in actual, rather than simulated, space conditions in order to verify these results.

However, because of the difficulty of conducting such experiments in live animals, most studies on reproduction in space have thus far been carried out in species such as fish or amphibians. The gametes and embryos of these species are comparatively easy to manipulate for use in reproduction experiments, reducing the need to maintain live animals. Mammalian embryos, on the other hand, can only be cultured for a few days, meaning that such experiments may require difficult in vivo procedures that could pose technical challenges for the astronauts. For this reason experiments on mammalian reproduction in live animals or gamete cells was considered unfeasible using present-day technology.

In a previous study, we found that freeze-dried spermatozoa can be preserved at room temperature without losing their fertilization capacity. This is advantageous for space experiments because the samples have lower mass and do not require a freezer for storage during launch or landing. Here, we propose to examine the effects of cosmic radiation on spermatozoa using freeze-dried samples. These freeze-dried spermatozoa will be kept on board the ISS in the Japanese Experiment Module "Kibo" and exposed to cosmic radiation for several months. After this sample returns to the ground, we will try to make offspring from them and examine the effects of cosmic radiation on sperm DNA.

This will be the first step for studying mammalian reproduction in space. We hope to expand on this study by developing an automatic culturing system for frozen embryos, as well as animal cages to maintain live animals in space, and ultimately to attempt to produce live offspring under space conditions.