

sides of double mylar dishes. Since He ions can only traverse a very limited distance, cells plated on the other side of a medium-filled mylar dish (target cells) would have no chance of being hit by He ions. After one side (with or without cells) was irradiated by the He ions, the target cells were collected for cytogenetic assay using the PCC technique. Our results show that the number of aberrations in cell irradiated group is slightly higher than those in medium irradiated group. Furthermore, when transfer the medium of cell irradiated group, chromatin fragments were produced in the target cells added to the medium, while no damage was observed added to medium irradiated group. These results clearly show that some species induced chromosomal damage exists in medium of cell irradiated group.

#### 128 Analysis of gene expression induced by hypergravity using DNA chip

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We investigated the p53 signal pathway by hypergravity in human glioblastoma cell line, A172. Hypergravity (20 g) induced the accumulation and the phosphorylation of p53 at 3 h. But hypergravity did not significantly induced Waf-1 or Bax. Then, we examined the expression of genes by using Human Oligo Chip 30K (Hitachi Software Engineering Co., Ltd.). This DNA chip contained oligo DNA from 30,000 genes. Any of p53 inducible genes did not induced, but some genes concerned with cell signaling pathway or cytoskeleton of the cell induced by hypergravity (20 g, 6 h). We considered that the p53 signal pathway by hypergravity is different from other p53 signal pathway like DNA damage signal. DNA chip revealed that cells induced many gene expressions to adapt the environment of hypergravity.

### Effects of electro-magnetic fields

#### 129 Effect of Extremely Low Frequency Electromagnetic Fields (ELFMF) on Mutations in pTN 89 Plasmids

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We examined the effects of extremely low frequency magnetic fields (ELFMFs) and/or X-rays on mutations using pTN89 plasmids. The plasmids were subjected to sham exposure or exposed to an ELFMF (5 mT), with or without X-ray irradiation (10 Gy). Increased mutation frequency was not detected following exposure to a magnetic field alone, or after sham exposure. Sequence analysis of the *supF* mutant plasmids revealed that base substitutions were dominant on exposure to X-rays alone and X-rays plus an ELFMF. Deletions were detected in only the combined treatments with X-rays and an ELFMF, but not with X-rays alone. From these results, we could not detect direct effects of ELFMFs on DNA, but exposure to ELFMFs immediately before or after X-ray irradiation may enhance the mutation frequency.

#### 130 Estimation of mutagenicity by exposure to complex magnetic field with static and 50 Hz

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Mutagenicity of complex exposure to static magnetic field(MF) and 50 Hz MF was investigated. We developed a exposure system that can generate a 5T static MF and a 1 mT 50 Hz MF simultaneously with temperature control. To investigate the mutagenicity, bacterial mutation assay (Ames test) using *Salmonella typhimurium* TA98 and TA100, and also yeast mutation assay using *Saccharomyces cerevisiae* XD83 were performed. It was found that gene conversion/recombination frequency in *S. cerevisiae* XD83 was slightly increased by exposure to a complex MF while point mutation frequency in *S. cerevisiae* and *S. typhimurium* was not affected. This result is consistent with previous studies for static MFs, however we observed smaller mutagenicity in this study than one by a 5T static MF alone. This suggests that complex exposure of 50 Hz MF with static MF might cause weak protective effects. In future study, different exposure condition will be examined for estimation of the effect of complex MF exposure that was generated in our environment.

#### 131 Effects of the Strong Static Magnetic Field on the Expression of Proto-oncogenes in HL-60 Cells

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We investigated the effect of 10 and 6 tesla (T) static magnetic fields (SMFs) on the expression of proto-oncogenes using western blot hybridization methods. 10 T is the highest magnetic flux density and 6 T has the strongest magnetic field gradient (41.7 T/