Drastic Enhancement of Survivability of Various Cells under Ultrahigh Magnetic Field

Makoto Shoda [1], Kazumasa Okuno [1], Susumu Kajiwara [1], Hirotada Mori [2], Katsuhiko Shirahige [3]
[1]Tokyo Institute of Technology, [2]Nara Institute of Science and Technology,
[3]Institute of Physical and Chemical Research.

Objective and methods

We found for the first time that the survivability of *Escherichia coli* under ultrahigh 5.2-6.2 tesla inhomogeneous magnetic field was 100,000 times higher than that of *E. coli* under a geomagnetic field of 5×10^{-5} tesla (0.5 gauss), as control as shown in Fig. 1. This finding was obtained using the newly developed superconducting magnet biosystem (abbreviated as SBS, as shown in Fig. 2), where an ultrahigh magnetic strength of 1 to 7 tesla can be produced and vario cells can be grown. Based on this new finding, we conduct the following research.

1. By means of DNA array assay and flow cytometry, the mechanism involved in such a drastic enhancement of the survivability of dying *E.coli* cells is clarified.
2. Gram-positive procaryotic *Bacillus subtilis* cells are used to prove that the ultrahigh magnetic field exerts an effect similar to that in the case of *E. coli*. The survivability enhancement mechanism is analyzed using the same methods as those for *E.coli*.
3. As a representative eucaryotic cell, *Saccharomyces cerevisiae* is subjected to the ultrahigh magnetic field in SBS and the enhancement of survivability is confirmed. DNA array assay and flow cytometry are used for analysis of the survivability enhancement mechanism.
4. Two types of mammalian cells, mouse leukemia cells, P388, and Chinese hamster fibroblast cells, V79, are grown under the ultrahigh magnetic field in SBS. Cells in the death phase due to exposure to antitumor agents or to apoptosis induction are subjected to the high magnetic field in SBS and an enhancement of the survivability of the cells is demonstrated. DNA distribution in the two cells is measured by flow cytometry and enzyme activities such as telomera related to the death of the cells are measured.

Expected results

1. The analysis of the mechanism involved in such a high survivability will reveal that the ultrahigh magnetic field is related to longevity of the various cells and leads to their immortalization. This indicates the possibility of immortalizati of human cells under the ultrahigh magnetic field in the future.
2. The proliferation of superconductive magnets will pave the way for the application of the ultrahigh magnetic field to various areas of biotechnology in the future.

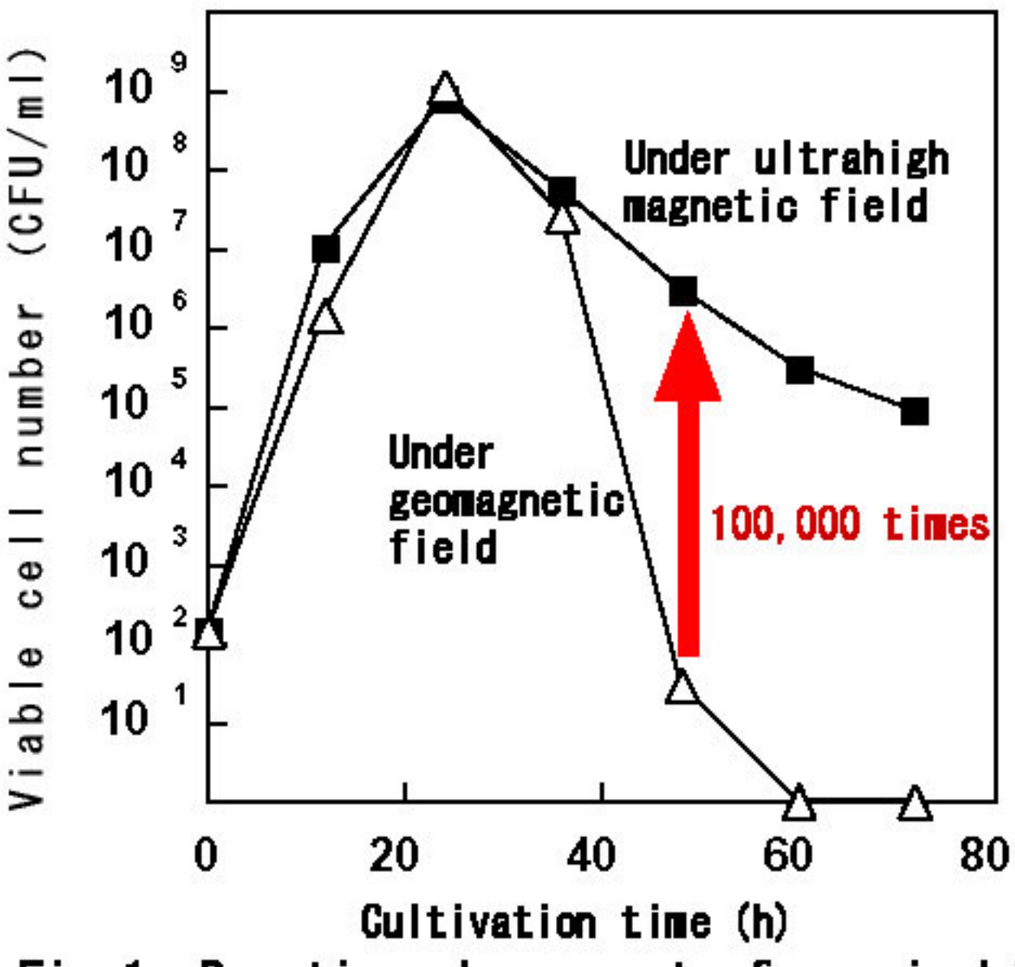

Fig. 1. Drastic enhancement of survivability of *E. coli* under ultrahigh magnetic field(■) compared with control of geomagnetic field (△).

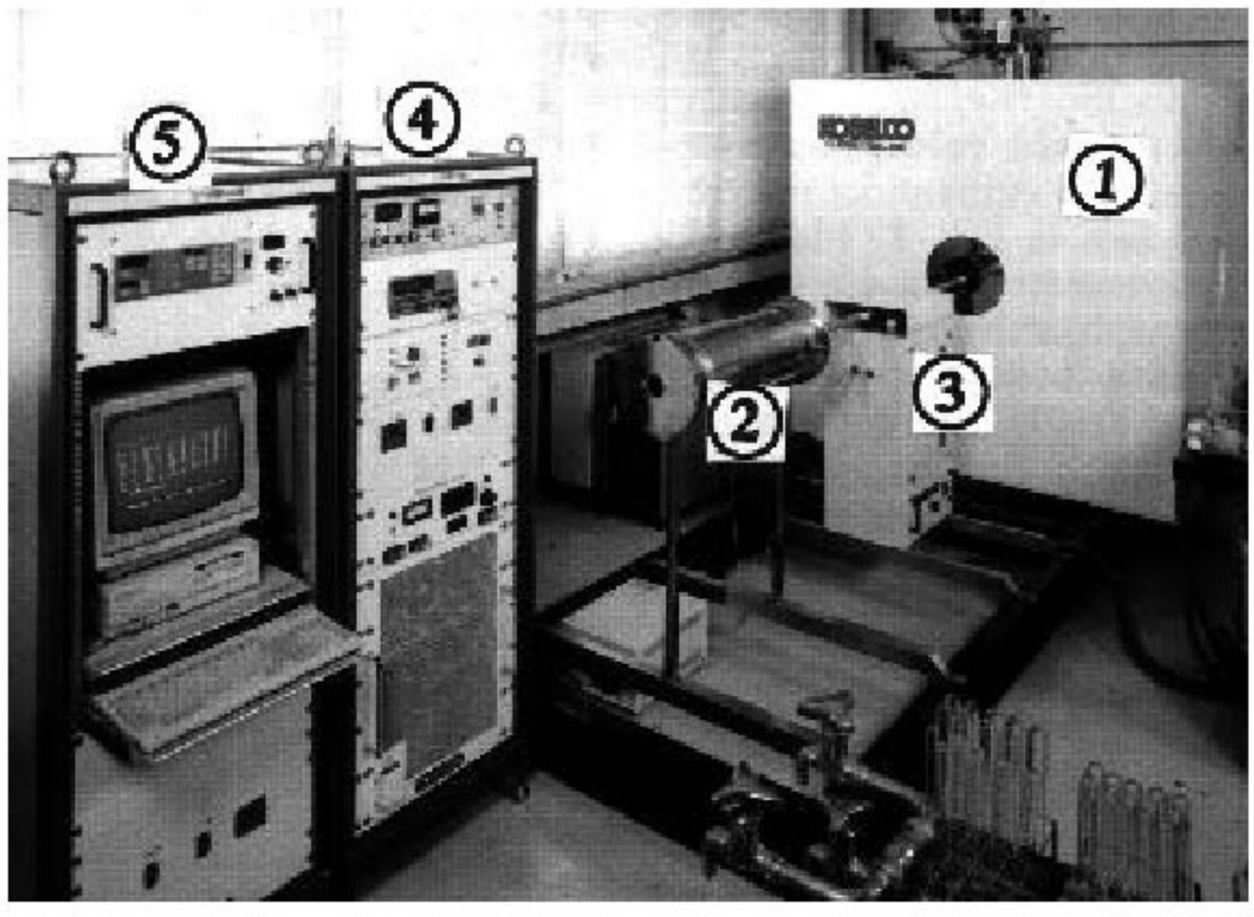

Fig. 2. A superconducting magnet biosystem (SBS) used.
① Magnet reactor,
② Control reactor,
③ Water circulation unit,
④, ⑤ Magnet and reactor control units.