【Grant-in-Aid for Scientific Research(S)】
Science and Engineering (Engineering Ⅱ)

Title of Project : Development of Magnetotactic Bacteria Producing Useful Substances, through the Reconstruction of Organelles Synthesizing Magnetic Particles

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Research Area : Engineering, Process engineering, Biofunction・Bioprocess
Keyword : Applied microbiology, Genome, Cell・Tissue, Biofunction utilization, Biotechnology

【Purpose and Background of the Research】

Magnetotactic bacteria synthesize intracellular magnetic particles (magnetite; Fe_3O_4) of approximately a few dozens of nanometers to 100 nanometers in size. The particles are covered by a lipid bilayer on their surface, and by modifying molecules such as proteins or DNA, they can be used for bioanalysis and recovery of various substances. Previous researches have revealed that the magnetic particles were synthesized inside subcellular organelles (magnetosomes).

In this study, we will analyze the functions and localization of the proteins involved in the magnetosome formation, and will reconstruct magnetosomes by reorganizing the genome. In addition, we will develop a technology which will allow the synthesis of magnetic particles in an adjustable manner, using cells, by modifying the protein's functions and the regulation of its expression.

【Research Methods】

In this study, we will use two strains of magnetotactic bacteria whose genome sequences have been clarified: *Magnetospirillum magneticum* strain AMB-1 (Figure A) and *Desulfovibrio magneticus* strain RS-1 (Figure B). We will prepare various gene-deficient strains based on the information on their genomes and proteins; and will analyze the morphology of the magnetic particles, and intracellular structures. Furthermore, to understand the functions and structures of magnetosomes at the molecular level, we will conduct an analysis of the intracellular localization of magnetosome proteins, and an analysis of the expression of the genes encoding magnetosome proteins.

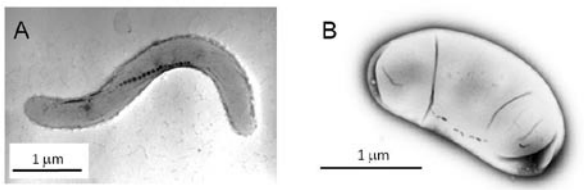

Figure Transmission electron micrographs of *Magnetospirillum magneticum* strain AMB-1 (A) and *Desulfovibrio magneticus* strain RS-1 (B).

Meanwhile, in previous studies, the deletion of a large gene region resulted in the obtention of mutant strains which lost the ability to form magnetosomes. We will reconstruct magnetosomes intracellularly by introducing genes involved in the formation of magnetosomes, into deletion mutants. In addition, we will modify the structure and functions of proteins by introducing mutations into their genes, will modulate the level and timing of protein expression, and will artificially control the functions of magnetosomes.

【Expected Research Achievements and Scientific Significance】

This study should provide guidance in the field of system biology and synthetic biology research. This study may also lead to the elucidation of the mechanism of biomineralization of iron oxide. Moreover, these basic researches are expected to lead to the expansion of the range of applications of microorganisms for industrial use, such as in the production of functional magnetic particles, or in the production of substances, using the magnetic recovery capability of the cells.

【Publications Relevant to the Project】

M. Tanaka, E. Mazuyama, A. Arakaki, and T. Matsunaga; "Mms6 protein regulates crystal morphology during nano-sized magnetite biomineralization *in vivo*." J. Biol. Chem., 286, 6386-6392 (2011).

H. Nakazawa, A. Arakaki, S. Narita-Yamada, I. Yashiro, K. Jinno, N. Aoki, A. Tsuruyama, Y. Okamura, S. Tanikawa, N. Fujita, H. Takeyama, and T. Matsunaga; "Whole genome sequence of *Desulfovibrio magneticus* strain RS-1 revealed common gene clusters in magnetotactic bacteria." Genome Res. 19, 1801-1808 (2009).

【Term of Project】 FY2011-2015

【Budget Allocation】 160,800 Thousand Yen

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