KAKENHI ESSAY SERIES No . 41 (Jun.2012)

Grants-in-Aid Supporting Microbial Function Application Research

By Tadashi Matsunaga
President, Tokyo University of Agriculture and Technology

From my university days to the present time, I have been engaged in research on the applications of microbial functions. The generic term “microorganism” stems from the fact these micro-level organisms can only be seen through a microscope. Microorganisms live all around us: on our skin, in our intestines, in the air, in the earth, and in the water of rivers, marshes and oceans. From days of old, they have been used in making foods such as soy sauce, *miso* paste, pickles, cheese, yogurt, and *sake* (rice wine). These days, they are used in seasoning with the amino and nucleic acids produced by microbial fermentation. In pharmaceuticals, which have greatly benefited humankind, microorganisms are used to make antibiotics, enzyme inhibitors, and immunosuppressant drugs. They also find application in such diverse fields as material production, environmental purification, and measurement. The many microbe species that exist in the activated sludge of sewage-processing plants work to decompose organic matter. Of late, they are also seen in the production of such biofuels as bioethnanol and biodiesel. Microbial application research is one of Japan’s strongest suits. With Dr. Hamao Umezawa (professor emeritus, University of Tokyo) having discovered kanamycin and Dr. Akira Endo (honorable emeritus professor, Tokyo University of Agriculture and Technology) having discovered statin, Japan’s research achievements in this field are highly appraised worldwide.

Fascinated with the myriad of microbial functions, I have spent the best part of 40 years investigating them. This began in my university days with research on microbial sensors and their applications and continues to my research today on the use of microorganisms in monitoring the water quality of reservoirs.

While working to elucidate the functions and applications of microorganisms, I have encountered some curious species. One was a microbe that internally produces a nano-size magnet. In the past, people would rely on magnets when traveling. In the natural world, there exist magnetic bacteria, which use nanomagnetics to navigate along lines of magnetic force from aerobic water surfaces to bottom environments suitable for anaerobic growth. Having started this research 30 years ago, we now have a laboratory at the university to continue advancing it. Utilizing a series of Grants-in-Aid, we have investigated and cultured magnetic bacteria, elucidated their functions, and created applications. Particularly during the period from 2001 to 2005, we were selected for grants under the category Specially Promoted Research, which was very significant as it allowed us to concentrate on our magnetic bacteria research. Being the first in the world to decode the bacteria's entire genome, we went on to elucidate the structure making up its magnet. In the process, we used a DNA chip to isolate the genes expressed and used in the magnet formation, and then we analyzed its proteome using mass spectrometry. Triggered by our research on magnetic bacteria, we substantially advanced research on magnetic nanoparticles applying it to proteins and to cell separation and measurement. We have also begun applying it to the medical field, such as drug delivery systems and hyperthermia treatments. In Europe and America, companies working on magnetic nanoparticles have gone global. As to fostering researchers, the young researchers who participated in our lab's Grant-in-Aid funded magnetic bacteria research projects are now professors or associate professors advancing research on bacteria and nanotechnologies at Hiroshima University, Kyoto University, Tokyo University of Agriculture and Technology, Waseda University, and Bogor Agricultural University. I am not only happy but also very proud of this outcome.

I cannot overstate the importance of the role that Grants-in-Aid have played along the path of my career as a researcher. For my individual research on microbial function applications, I have been continuously supported by Grants-in-Aid, including grants for Specially Promoted Research, Scientific Research (S), (A) and (B), and General Scientific Research (B). Each of these grants had a time limit, ranging from two to five years. In the fall of their final

year, I would need to prepare applications to submit for my next grants. When writing them, I would think of new themes, put in order my own achievements, assemble related papers, and map out domestic and international trends. I was always thrilled to be selected for a grant as the culmination of these efforts. I have also been privileged to do research under Grants-in-Aid for Specially Promoted Research and Scientific Research on Priority Areas. When I was young, I applied and was selected for publically recruited research teams. After I became a little more senior, I was able to pioneer new research domains with researchers from other universities and go on to lead research groups. That research afforded me the opportunity to spend more-relaxed time in interacting with researchers in mine and different fields in other universities. I still enjoy my association with many of those researchers today.

Under the Grants-in-Aid program, funding in support of basic research has been expanded year on year. Continuous improvements have been made to the application screening system including the establishment of a peer review system and a multi-year Fund that allows more flexibility in carrying grants over into the next fiscal year.

At Tokyo University of Agriculture and Technology, we are exerting a strong effort in fostering talented young researchers. Six years ago, the university introduced a tenure-track system. Issuing wide international recruitments, we have assembled an excellent faculty and staff, while creating an operational environment that eases the faculty's administrative burden, making it easier for them to concentrate on their research activities. This has contributed significantly to a higher percentage of young researchers being selected for Grants-in-Aid. In the future as well, the fostering of young researchers as future global actors will be a vital pillar of our university's reform initiatives.