

What frontiers for Frontier?

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The Human Frontier Science Program is a bold attempt to support the next century's biology research. Its horizons should not be limited.

THE Human Frontier Science Program (Frontier), a Japanese initiative supporting international research on the brain and the molecular mechanisms of biological functions, has reached a critical juncture. After the first three-year phase, funded largely by Japan, the programme is now attracting financial support from many countries and its future direction is beginning to be questioned. As one of the principal architects of Frontier and as a former member of its council of scientists, I would like to explain the philosophy behind it and argue that it should maintain its basic principle of promoting pure life science by actively encouraging cooperation among many research fields in various disciplines.

Until the beginning of the Meiji restoration in 1853, Japan had isolated itself from the rest of the world for more than 200 years and the country did not participate in the development of science and technology happening elsewhere. Nevertheless, a strong education system had been maintained in Japan, and there was a reservoir of intellectuals able to take advantage of the new knowledge in science and technology that became available at the time of the Meiji restoration. British observers correctly evaluated the progressive engineering education system in Japan in those early days. Two articles in *Nature* (16, 44; 1877 and 71, 150; 1904) explained that in England technical education was conducted without scientific education to produce craftsmen, whereas in the rest of Europe, in particular in France, emphasis was placed on theoretical science without practical training. They then reported and praised the fact that for the first time an engineering education system with a well-balanced mixture of science and engineering had been established at the Imperial College of Engineering, the present Faculty of Engineering at the University of Tokyo.

I admit that Japan subsequently put too much emphasis on technology, particularly on areas with immediate applications. But at the same time I want to make it clear that about 120 years ago Japan established the basic concept that the fusion of science and technology, and balanced cooperation between them, are indispensable for the true development of both. This principle lay behind the establishment of Frontier,

which I think represents the Japanese genius at combining apparently different disciplines to create new fields of study.

The aim of Frontier is to help researchers in all fields to understand the true nature of life. In concrete terms, it provides research grants, long- and short-term fellowships and supports workshops, with a total annual budget now standing at about \$34 million (soon expected to rise to nearly \$40 million with contributions from the United States and other countries). In addition, it emphasizes the importance of supporting young researchers.

The purpose of the programme is to clarify the functions of living organisms by a 'molecular level' approach and by understanding brain functions. There are two 'priority fields': first, expression and transfer of genetic information, morphogenesis, molecular recognition and responses, and energy conversion; and second, perception and cognition, movement and behaviour, memory and learning and language, and thinking. Popular fields with their own societies and journals, such as cellular biology, immunology and developmental biology, were intentionally avoided. Through such an approach the intention was to encourage researchers in fields other than biological science to participate, as it was felt that knowledge can be acquired only when researchers are not confined to narrow frameworks.

Some participants and organizers of Frontier, unaware of this fundamental philosophy, have tried to narrow its priority fields to the above-mentioned conventional fields by claiming that 'molecular' fields are too broad and that there are too many research proposals to review. Such action is contrary to the basic philosophy of the programme. These priority fields were selected after careful consideration of how life-science research might develop without being confined to the framework of present-day research and should not be changed for trivial reasons, such as the difficulty of evaluating proposal applications.

I admit that there have been misunderstandings about the programme in the past. The fact that it was initiated by technologically advanced Japan and that its priority fields appeared to be oriented towards technology meant that some people suspected it was a strategy for Japan's technology development. But

now that an international peer-review system is functioning effectively, and the fairness of the system is well established, these doubts have been dispelled. Also, the intellectual property belongs to its creator(s), so Japan will not be the sole beneficiary.

I have said Frontier provides opportunities to examine the complex functions of life via an all-out effort of science and technology. Physics or engineering technologies (computers, robotics, electronics, materials science and so on) should provide powerful tools. Their contributions are not limited to hardware; the mode of thinking in fields such as mathematics and physics, information-science technology and engineering should stimulate the creation of new concepts in biological research. It is true that methods alone will not produce good research, but it is also a characteristic of modern science that highly sophisticated tools are indispensable for its evolution.

I regard biology as having entered a new phase in which it can develop with highly sophisticated methodologies, and believe that its progress can be quickly accelerated by a balanced perspective which views science and technology as one entity. I am convinced that Frontier is a unique project in which ideas and methodologies, science and technology, and physical and biological sciences, can be fused to promote life-science research. What is more, it was initiated by Japan, a country that had not previously been a significant international leader in basic science. Therefore, I believe that many researchers in various scientific and technological fields should join Frontier, and I firmly believe that it should continue to be open to and welcome their participation. Finally, as someone who has been involved from its inception, I rejoice in the fact that Frontier is developing into a truly international project, thanks to the people who have been connected with it — in particular those in the Secretariat in Strasbourg — and to the recent financial contributions from many countries. I ask researchers of the world to foster the healthy growth of this new-born baby. □

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