

# **RIKEN: Leading Japanese Science to Global Pre-eminence.**

Report of the  
6<sup>th</sup> RIKEN Advisory Council (RAC)  
to the President of RIKEN,  
The Institute of Physical and  
Chemical Research.

**2006/9/5**  
**RIKEN Advisory Council (RAC)**

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## **EXECUTIVE SUMMARY**

### **Introduction**

The 6<sup>th</sup> RIKEN Advisory Council (RAC) met in Tokyo on June 7-9, 2006 with all but three members in attendance. Professors Zach W. Hall and Yuan-Tse Lee were designated as Chair and Vice-Chair, respectively. The Terms of Reference, stated below, were given by President Noyori in his opening remarks and were accepted by RAC. At the end of the meeting, Dr. Hall and the RAC members presented their findings to the President and Executive Directors.

#### **Terms of Reference – 6<sup>th</sup> RIKEN Advisory Council (RAC) Meeting**

- A.* To review the response of RIKEN to the recommendations of the 5<sup>th</sup> RAC meeting (“Strengthening Scientific Governance in an Era of Change”).
- B.* To evaluate the overall quality and international standing of scientific research at RIKEN.
- C.* To evaluate contributions to the external research community by research infrastructures such as the open-use facilities and research resource centers developed and operated by RIKEN; also to evaluate plans for future development and operation of such research infrastructure.
- D.* To provide recommendations to the RIKEN management on how to enhance RIKEN’s international visibility, to strengthen RIKEN’s presence within the global scientific community, and to refashion RIKEN into a research organization with a global outlook.

## Summary of Findings

The RAC was highly impressed by the overall quality of science at RIKEN, which compares favorably with that of other leading research institutions worldwide. In particular, the breadth and scope of the science at RIKEN, including large infrastructure projects, mission-directed team projects, and discovery-oriented research in the physical and life sciences, is a special feature of RIKEN that distinguishes it from other major research institutions.

The 6<sup>th</sup> RAC was pleased with the vigorous and imaginative response by RIKEN, under the leadership of President Noyori, to the recommendations of the 5<sup>th</sup> RAC. A major theme of the previous report centered on recommendations to strengthen scientific governance and the mechanisms by which the scientific priorities of RIKEN are selected. The President has established a strong system of advisory committees and a transparent, broadly-based governance regime that balances “top-down” and “bottom-up” management. Most importantly, President Noyori has projected a compelling vision for RIKEN, based in its history and directed toward the future that gives the institution identity, vitality, and purpose.

The 6<sup>th</sup> RAC approves of the emerging role of RIKEN in providing open-use, large scale infrastructures for the Japanese scientific community. The infrastructure projects, such as SPring-8, the Nishina Center for Accelerator-Based Science and the planned petaflop supercomputer, make appropriate use of RIKEN’s unique capabilities in the national interest and expand the scientific resources of the organization. The RAC cautions, however, that this emerging role of RIKEN should not imperil or jeopardize its traditional role as a source of innovative science. RAC urges that RIKEN use these infrastructure projects as one of the principal means by which it can enhance its relations with universities and other research institutions and engage them as partners, rather than competitors, in the scientific enterprise in Japan. Further, the RAC believes that these projects will also be vital in the pursuit of RIKEN’s explicit goal of achieving global leadership in science.

The scientific eminence of RIKEN has given it new international standing so that it is poised to become a leader of the global scientific community. We suggest that it has a particularly important role to play in the development of science in Asia. The 6<sup>th</sup> RAC

sees a bright future for RIKEN and commends the Japanese government for the foresight and wisdom of its investment in RIKEN.

## **Recommendations**

The principles enunciated in the Noyori Initiative continue to be strong and relevant guidelines for the continued development of RIKEN. To organize our recommendations for the Executive Summary, we frame them within the Noyori Initiative, a high-level strategic vision for the future of RIKEN announced by President Noyori at the end of 2003.

### **The Noyori Initiative**

1. To increase the visibility of RIKEN
2. Maintaining RIKEN's outstanding history of achievements in science and technology
3. RIKEN that motivates researchers
4. RIKEN that contributes to society and mankind
5. RIKEN that contributes to culture

We do, however, use the principles of the Noyori Initiative in a slightly altered order, reflecting the particular priorities of the discussion at the 6<sup>th</sup> RAC meeting.

### ***Maintaining RIKEN's outstanding history of achievements in science and technology (NI 2)***

#### **RAC Recommendation 1a: Strengthen Science and Technology at RIKEN**

- Protect and nourish the core mission of discovery and innovation in the Centers and Institutes and in the Frontier Research System.
- Through infrastructure and other means, extend the scientific relations of RIKEN with other institutions in Japan and abroad.

- Continue to support and encourage internal collaboration by Institute policies and initiatives.
- Carefully balance investments in large infrastructure projects with the need to protect small, laboratory based basic research.
- Strengthen bioinformatics at RIKEN by recruiting more specialists and by creating integrated, easily accessible RIKEN-wide databases as well as common data standards, data release policies.

**RAC Recommendation 1b: Continue to strengthen RIKEN's scientific governance**

- Further strengthen the process of establishing scientific priorities.
- Give strong and unequivocal representation to scientific values at the highest levels of decision-making within RIKEN.
- Expand and extend the External Advisory Board to include representatives of universities, and other research institutions.

***RIKEN that motivates researchers (NI3)***

**RAC Recommendation 2: Enhance the scientific personnel and culture of RIKEN.**

- Continue and strengthen pro-active efforts to recruit more women scientists, particularly Japanese women scientists.
- Continue efforts to recruit non-Japanese personnel at junior and senior levels.
- Increase the use of English for both scientific and administrative matters throughout RIKEN.
- Consider the most appropriate means, including the possibility of establishing an international graduate school, of increasing the number of graduate students at RIKEN.

***RIKEN that contributes to society and mankind (NI4)***

**RAC Recommendation 3: Increase RIKEN's contributions to society**

- Enhance the translation of RIKEN discoveries into therapies by expanding clinical partnerships.

- Continue to develop technology transfer so that RIKEN discoveries may benefit society through useful products and through economic activity.
- Expand educational activities that inform the public about science and RIKEN
- Cultivate scientific relationships with other countries in Asia.

***To increase the visibility of RIKEN (NI1)***

**RAC Recommendation 4: Enhance RIKEN’s visibility and international standing**

- Support and expand communications, using outside consultants and experts if necessary.
- Intensify international efforts to make RIKEN more visible.
- Create a strong RIKEN “brand”.
- Use the President as an effective international ambassador for RIKEN.

***RIKEN that contributes to culture (NI5)***

**RAC Recommendation 5: Nurture the exchange between scientific and humanistic cultures.**

- Encourage cultural events, such as concerts or exhibitions at the various RIKEN centers, institutes, or campuses.
- Continue initiatives to educate the broader Japanese culture about scientific values and modes of operation and about science as a “human” enterprise that satisfies humanistic values such as curiosity, esthetics, and the desire to find meaning and structure in our lives and in the universe.

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**Report of the 6<sup>th</sup> RIKEN Advisory Council (RAC) to the President of RIKEN,  
The Institute of Physical and Chemical Research.**

## **INTRODUCTION**

The 6<sup>th</sup> RAC confirms the finding of the 5<sup>th</sup> RAC two years ago —that RIKEN has reached national eminence and, in terms of scientific quality, has taken its place among the most prestigious international research organizations, including the National Institutes of Health in the United States, the Weizmann Institute in Israel, the Max-Planck Society in Germany, the British Medical Research Council, or the French National Research Organizations, CNRS and INSERM.

Moreover, during the last two years, RIKEN has greatly improved its scientific governance by strengthening the role of the President and by establishing an advisory structure for setting scientific and other priorities. We are particularly impressed by the outstanding leadership qualities that President Noyori has shown and believe that his continuing leadership will be crucial for RIKEN's future.

### **The Importance of Basic Research for Innovation**

We believe the Japanese government has been far-sighted in making a major investment in RIKEN. This investment has been highly successful in bringing RIKEN to a position of national leadership and now to the brink of international prominence and leadership.

In contrast to “old” manufacturing economies where growth and competitiveness depended on investments in material infrastructure and industrial capital, competitiveness in the global “knowledge economy” increasingly depends on investment and development of human and technological capital. Japan's extraordinary growth over much of the second half of the 20<sup>th</sup> century was largely dependent on investments

in manufacturing capability, technological development, and incremental innovation. But, today, Japan's economy is undergoing an extensive transformation in which success in an increasingly global marketplace will depend upon new "disruptive" innovations in ideas and in technology. The generation of these new ideas and technologies depends upon sustaining and expanding a research environment that fosters creativity and gives ready access to new technologies as they arise. RIKEN played an important role in the transformation of the Japanese economy in the 1920s and the 1930s when the cornerstones for Japan's technology-based economic growth during the second half of the 20<sup>th</sup> century were laid. We believe that RIKEN has a comparable role to play in the transformation of JAPAN to the new, global economy over the next decades.

### **The "New" Global Frontiers of Science**

In the same way that economies are being transformed, research and innovation are becoming global activities, with an increasingly important part of worldwide scientific research taking place in emerging economies in Asia, such as Korea, Taiwan, Singapore, China and India. Competition for research talent is no longer localized to individual countries but is becoming global, as leading scientists move from country to country. In the past, many Japanese scientists spent their formative years abroad—first in Germany and then, in the post-war years, largely in the United States. As Japan has moved towards the forefront of research, increasing numbers of young scientists come to Japan to be trained, many of them from Asian countries. Japan has a major role to play in training these young scientists; it will also find that its best scientists will be offered jobs elsewhere; and that it will need to be able to recruit internationally to remain competitive.

### **Toward World Leadership – Globally and at Home**

Building upon its past successes, we believe RIKEN has the potential to become a world leader in many areas of research—and increasingly a place where the best minds in the world will want to work.

Among research organizations in Japan, RIKEN now stands out not only in research quality, but also in its international outlook. In contrast to Japanese universities, which remain relatively closed to non-Japanese scientists, a significant number of foreign

scientists work at RIKEN, including a significant number of principal investigators who are not native Japanese. The numbers of non-Japanese scientists in leadership positions at even the most prominent Japanese universities are far below what RIKEN has achieved. Against this background, we believe RIKEN can function as an agent of change within the Japanese scientific community, and lead it to a position of world leadership. To accomplish this ambitious role, RIKEN needs to strengthen its relations with other institutions in Japan, engaging them as partners; it also needs to continue its efforts to become more international. These linked challenges are two of the main themes of this report.

### **Structure of the Report**

In the Executive Summary, we summarize our main findings and list the recommendations of the 6<sup>th</sup> RAC, using the Noyori Initiative as a framework. In what follows, we first evaluate RIKEN's response to the recommendations of the 5<sup>th</sup> RAC. We then present the same recommendations of the 6<sup>th</sup> RAC within a different framework, by grouping them with respect to four main thematic ideas developed by the RAC:

1. Sustaining and Enhancing Scientific Excellence
2. Extending RIKEN Relationships within Japan
3. Infrastructure and the Budget
4. RIKEN's International Role: The Global Challenge

## THE 6<sup>th</sup> RAC MEETING

The 6<sup>th</sup> RAC meeting was held from June 7-9, 2006 at the Tokyo Bay InterContinental Hotel. The meeting was attended by all members of RAC with the exception of Guy Ourisson, Geraldine Kenney-Wallace, and Hans Wigzell who were unable to attend for personal reasons. The Terms of Reference of the 6<sup>th</sup> RAC were given by RIKEN's president, Dr. Ryoji Noyori, in his opening remarks.

### **Terms of Reference - 6th RIKEN Advisory Council Meeting**

- A. To review the response of RIKEN to the recommendations of the 5<sup>th</sup> RAC meeting ("Strengthening Scientific Governance in an Era of Change").
- B. To evaluate the overall quality and international standing of scientific research at RIKEN.
- C. To evaluate contributions to the external research community by research infrastructures such as the open-use facilities and research resource centers developed and operated by RIKEN; also to evaluate plans for future development and operation of such research infrastructure.
- D. To provide recommendations to the RIKEN management on how to enhance RIKEN's international visibility, to strengthen RIKEN's presence within the global scientific community, and to refashion RIKEN into a research organization with a global outlook.

During the first day of the meeting, the RAC members heard presentations by the President and Executive Directors on RIKEN's recent evolution, issues that the organization is facing, and the changing environment within which RIKEN operates. President Ryoji Noyori presented his vision of the future of RIKEN as well as his analysis of the most urgent issues that RIKEN currently faces. Presentations by RIKEN's Executive Directors featured the following:

- an overview of research resource allocation policies
- an analysis of RIKEN research activities
- an overview of the RIKEN administration

- a summary of advanced research infrastructures managed or developed by RIKEN
- RIKEN's intellectual property strategy
- an outline of the role of the RIKEN Science Council

During the second day of the meeting, RAC members split into two groups, one focused on the life sciences and one on the physical sciences, to hear presentations from the directors and the chairs of the Advisory Committees for each of the centers and institutes.

In addition to these presentations, RAC members also received the following materials:

- the RIKEN White Paper
- the White Papers prepared for each of the Advisory Councils for the centers and institutes.
- the reports made by each of the Advisory Councils
- publications of RIKEN and, where available, annual reports of the various centers and institutes

Presentations were followed by discussion and brief *in-camera* sessions by RAC members. A first draft outline of the report was developed during a working dinner, followed by an extensive writing and discussion session on the morning and early afternoon of the third day of the RAC meeting. At the end of the meeting, Drs. Zach W. Hall and Yuan Tseh Lee, the Chair and Vice-Chair, respectively, of the 6<sup>th</sup> RAC, met with President Noyori; Dr. Hall then presented a summary of the report of the 6<sup>th</sup> RAC to the RIKEN President and the assembled Executive Directors.

## **ASSESSING THE RESPONSE TO RECOMMENDATIONS OF THE 5<sup>th</sup> RAC**

### **General Assessment**

Overall, the RAC is extremely impressed with the progress that has been made in the two years since our last visit. In particular, we applaud the vigorous leadership of President Noyori in implementing the recommendations of the 5<sup>th</sup> RAC. A signal achievement of the President has been to increase the sense of unity and coherence of RIKEN, whose Centers and Institutes span a remarkable range of science, extending from the structure of the atomic nucleus to cognitive neuroscience. Among the most important recommendations of the 5<sup>th</sup> RAC was that interactions between the scientists in the many Institutes and Centers be fostered and that a strong strategic vision for RIKEN be established within which scientific priorities for RIKEN as a whole could be formulated. The 5<sup>th</sup> RAC further encouraged a “top-down, bottoms-up” approach in which the President’s role, as well as that of the Institute and Center Directors be strengthened. Through the President’s policy of encouraging “independence without isolation”, impressive progress has been made in creating a single, unified mission for RIKEN that encourages strong interactions among its components. Most importantly, the President, through his personal leadership, has articulated an exciting vision for RIKEN that is firmly rooted in its history, but clearly directed toward the future.

### **Scientific Governance**

A central theme of the recommendations of the 5<sup>th</sup> RAC was the issue of scientific governance, which we recommended be strengthened through an open and accountable process. To address this issue, the President and Executive Directors have established a comprehensive and carefully conceived organizational structure for decision-making:

- The President strengthened the Research Priority Committee which gives broad representation in the matter of research priorities and he personally assumed the position of Chair, underlining the importance of the Committee as the central body for research priority recommendations;

- He established the Science Council, which includes RIKEN scientists at various levels and from different disciplines, as a valuable means of obtaining “bottoms-up” advice from the RIKEN scientific community;
- He established regular, formal meetings with the Institute and Center Directors to more fully utilize their talents; and
- He established the RIKEN Advisory Board as a group of outside experts who meet regularly to advise him.

These committees, plus the RAC, provide the President with a wide range of input drawn from a diverse constituency and ensure broad participation in decision-making at RIKEN.

### **Management and Administrative Services**

The 5<sup>th</sup> RAC suggested improvement in management and administrative functions, urging RIKEN to seek excellence not only in its science activities, but also in the level of professionalism in its administration. Through a process involving broad participation of administrative personnel, particularly young administrators, and through a program of Ten Important Managerial Items, RIKEN has engaged in a vigorous program of managerial and administrative improvement. In addition, RIKEN made changes in its scientific personnel system that represent progress toward a coherent long-term personnel management strategy. A member of the 6<sup>th</sup> RAC did note that the administration continues to use a terminology that some believe is out-dated (“gyomu kanri”) and suggested that use of this term may convey the impression of an overly bureaucratic approach.

### **Reorganization of Centers and Institutes**

RIKEN took three important steps, based in part on recommendations of the 5<sup>th</sup> RAC, to address issues of scientific management at the center and institute level. First, as recommended, the Frontier Research System was reviewed, its objectives redefined and its various roles clarified; second, the Harima Institute was reorganized as the RIKEN SPring-8 Center; and third, the accelerator facilities of the Wako Institute are now organized as a separate center, the Nishina Center for Accelerator-Based Science. We note that the two latter changes are made possible by RIKEN’s status as an

Independent Administrative Unit. The RAC approves each of these changes as strengthening and clarifying the organization of the respective research centers. We address additional issues related to the large-scale facilities later in the body of the report.

## **Scientific Personnel**

The 5<sup>th</sup> RAC made several suggestions regarding scientific personnel:

- Increase the quality of post-doctoral fellows and graduate students.
- Increase support for graduate students.
- Support for those ending their contracts.
- Increase the number of foreign scientists at RIKEN.
- Increase the number of Japanese women scientists in leadership positions at RIKEN.

RIKEN has made commendable progress in each of these areas. We especially appreciate the formation of the Career Support Office and the establishment of programs to support graduate students. We also understand that many of these issues are difficult ones, however, that will not be solved in a two year period. To help RIKEN continue to make progress in several of these areas, we make additional recommendations later in the report.

## **Strategic Relationships and Technology Transfer**

RIKEN has continued to make progress with respect to its strategic relationships. We particularly note the formation of the Center for Intellectual Property Strategy (CIPS) and consolidation of dispersed collaborative programs with industry within that office and the appointment of a senior executive from industry to head the office. We will be interested in future years to assess the success of this office as it becomes more completely developed.

## CHALLENGES FOR THE FUTURE

*When asked for the secret of his success, the Canadian hockey star, Wayne Gretzky, said “Most players skate to where the puck is; I skate to where it’s going to be.”*

After a period of growth and expansion, with the addition of 8 new Institutes over the last 10 years, RIKEN has achieved a position of scientific pre-eminence in Japan with increasing recognition world-wide. The challenge now facing RIKEN is how to adapt to a static or declining core budget while maintaining and enhancing its position of scientific leadership within Japan and beyond. Over the next few years, RIKEN’s success will increasingly depend upon its ability to make shrewd strategic decisions about the deployment of its resources, including financial, physical, human and organizational components. RIKEN will not have the luxury of placing a large number of bets about which types of science will be the most productive, but will be required to make hard choices between different alternatives. Although no one can predict the future, RIKEN’s challenge will be to make choices that will give it the best chances of future success: in short, to try to figure out how “to skate to where the puck is going to be”.

### **Sustaining and Enhancing Scientific Excellence**

Scientific excellence is not the only yardstick by which the success of RIKEN will be judged, but it is the most essential. It is the quality that enables other goals (contribution to society, visibility, training of young scientists) to be fulfilled. We thus start with the most important of RIKEN’s challenges, that of maintaining and extending the quality of the science that it does. We assess the progress that RIKEN has made in scientific achievement since the last RAC meeting and make specific recommendations for the future.

#### *Assessment of Overall Quality and International Standing*

The quality of the science at RIKEN is extremely high; furthermore the high quality extends across an impressive range of physical and life sciences. RIKEN has achieved world-wide excellence in many spheres, not just in one or two: in a number of areas, RIKEN may be said to lead the world; in others, it is among the top few in the world; and

in others, it can be considered to be among the top ten. A remarkable feature of science at RIKEN is its breadth: it spans broad areas of science ranging from sub-atomic physics to cognitive neuroscience. RIKEN has achieved distinction on a variety of scales of scientific organization: in very large infrastructure projects, such as SPring-8 and the Nishina Center for Accelerator-Based Science, where it is among the top few in the world; through its participation and leadership in comprehensive world-wide efforts, such as genome sequencing, proteomics and the HapMap project (in the latter case, RIKEN made the largest contribution of any research institution in the world) and through the innovation and creativity of its individual laboratories in the Discovery Research Institute, the Frontier Research Systems and in the Institutes and Centers.

RIKEN has built on a long and distinguished history of achievement in the physical sciences, and also, through decisive and focused recent investments, has attained international prominence in the life sciences in a remarkably brief period of time. A key ingredient of RIKEN's success is the quality of its leadership. The President, the Executive Directors and the Directors of the Centers, Institutes and Systems have provided RIKEN with leadership that is creative, energetic and that embodies the highest scientific values. The Directors of the new Institutes and Centers have done an exceptional job in recruiting outstanding scientists, both those who are well-established and those who are in the very early stages of their careers. Moreover, they have given them the scientific freedom and the resources to perform at the highest level. We applaud the Japanese government for its sustained and strategic investment in RIKEN, an investment that will bring economic, healthcare and quality-of-life benefit to the Japanese people – and to the world – for many years to come.

### *Science at RIKEN*

The challenge for RIKEN is to sustain and enhance its high level of scientific achievement. As we discuss below, RIKEN will face the challenge of competing in an expanding international marketplace under constrained budget conditions. To consolidate and improve its international standing, it will need to obtain maximal benefit from all of its resources, using them synergistically where possible. RIKEN must also select its scientific priorities carefully, with the best possible scientific input. Finally, it must continue to recruit the very highest quality scientists, providing them with an environment in which they can achieve the highest expression of their scientific potential.

### **Recommendation 1a: Strengthen Science and Technology**

- Protect and nourish the core mission of discovery and innovation in the Centers and Institutes.
- Continue to support and encourage internal collaboration by Institute policies and initiatives.
- Strengthen bioinformatics at RIKEN by recruiting more specialists and by creating integrated, easily accessible RIKEN-wide databases as well as common data standards, data release policies.

RIKEN sponsors a large and complex portfolio of science, ranging, as noted above, from the management of large infrastructure projects to highly-directed, mission-oriented, large-scale team projects, to curiosity-driven research carried out by individual laboratories. In all of these cases, it is the imagination and creativity of individual scientists that drive the discovery of new insights and the development of new technologies. To thrive, RIKEN must continue to encourage and enhance the ability of its scientists to follow their best ideas and to develop new ones.

Even in individual laboratories, scientists increasingly work through collaboration, bringing skills and ideas from different disciplines together to attack a common problem. As a scientific institution with many centers that are geographically dispersed, encouraging collaboration among its scientists is especially important for RIKEN. We very much appreciate the efforts of the President to encourage collaborative research programs through the President's Discretionary Fund and urge that he continue and expand these efforts. As one suggestion, we suggest that he consider sponsoring a series of Presidential Workshops, perhaps several per year, in which relevant RIKEN investigators from several centers and disciplines come together for discussion of a topic at the boundary of several disciplines. The topics should be chosen judiciously to bring together investigators who may not otherwise interact, with the hope that they provide an occasion or an opportunity for new collaborations to form. Such workshops might offer RIKEN an opportunity to explore new areas of scientific development, such as those at the interface of the physical and life sciences, in both of which RIKEN has great strength. In this vein, we noted with great interest examples in which two Institutes have organized common retreats to bring their scientists together, a practice that we strongly encourage where appropriate.

In this context, we urge that RIKEN consider how the Institute Laboratories (ILs), which have historically been the backbone of science at RIKEN, fit into the larger mission of RIKEN. The ILs are now scattered among three centers (the RIKEN DRI, the RIKEN Nishina Center and RIKEN SPring-8 Center). To obtain maximum benefit from the ILs, they should not be isolated, but interactions between the ILs and laboratories in the Centers should be encouraged. A redefinition of the roles and status of the ILs and how they interact with the Centers from the broad perspective of the mission of RIKEN might be achieved by the newly-created Science Council to the benefit of both the ILs and RIKEN.

RIKEN can further enhance its scientific mission through collaborations with other institutions in Japan and beyond. We address this below in detail, but note here its importance to fulfilling the scientific goals of RIKEN.

RAC also recommends that RIKEN strengthen bioinformatics at the RIKEN life sciences institutes by hiring more specialists in this area and by creating new, integrated databases with user-friendly access. Easy integrated access for RIKEN scientists and those outside RIKEN would allow the data generated at RIKEN to be more fully exploited and would increase RIKEN's visibility and stature. Although some effort is made in individual institutes to create databases with specialist functional annotation, a RIKEN-wide strategy is needed to develop transparently accessible databases based on international standards and integrated around data types such as genes, sequence and structure. At a minimum, data generated anywhere within RIKEN should be easily available to all RIKEN scientists. RAC believes that the best way to accomplish this is through a distributed data integration model in which data is handled locally, but according to RIKEN-wide standards for data storage, management and exchange. To speed the process and provide optimal interoperability, the adoption of existing data exchange standards and protocols would likely be easier than inventing new ones. To facilitate the construction of such integrated data resources, we suggest the appointment of an Institute-wide director of information sciences and databases.

**Recommendation 1b. Continue to strengthen scientific governance.**

- Further strengthen the mechanism of setting scientific priorities.
- Give strong and unequivocal representation to scientific values at the highest levels of decision-making within RIKEN.
- Expand and extend the External Advisory Board

We appreciate the mechanisms that RIKEN has established to set unified scientific priorities. We believe that these procedures could be further strengthened in two ways. First, we believe that scientists should be more explicitly represented at the highest levels of decision-making. To this end, we suggest that the President consider the appointment of two senior scientists, one from life sciences and one from the physical sciences, to the Research Priorities Committee to further advise him. These should be individuals who command the highest scientific respect of their colleagues, who have a broad view of contemporary science, and who are able to give advice in the overall interests of RIKEN, rather than to represent a specific interest or discipline.

Second, we believe that the External Advisory Committee might be strengthened by additional members from universities, from other research institutions, and perhaps from the public sector. The External Advisory Committee could be a valuable source of advice and, as described in the next section, it could also be a key element in RIKEN's efforts to extend its scientific and other relationships within Japan.

Although the 6<sup>th</sup> RAC was informed in welcome detail about the mechanisms of setting scientific priorities, we heard relatively little about which specific priorities have been proposed and about the rationale for the particular choices that have been made. We would also be interested in understanding how the scientific priorities set by RIKEN relate to the priorities set by MEXT. We request that at the next (7<sup>th</sup>) RAC meeting, the scientific plans and priorities of RIKEN be one of the major topics for discussion.

**Recommendation 2. Enhance the scientific personnel and culture of RIKEN**

- Continue efforts to recruit more women scientists, particularly Japanese women scientists.
- Through the most appropriate means, increase the number of graduate students at RIKEN.

RIKEN, where 7% of all senior scientists are women, has played an important role in opening scientific opportunities in Japan for talented women scientists. Even so, RIKEN realizes, as we do, that this level is insufficient and that much remains to be done. It is a continuing challenge to identify and recruit outstanding women scientists, especially Japanese women scientists, and to help foster the careers of those who are hired. We strongly urge RIKEN to continue its efforts in this direction. In addition to pro-actively hiring the best female scientists in Japan at all levels of the organization, RIKEN should further improve the environment for woman scientists through day care facilities and appropriate child-care support. Various additional measures, such as consciously increasing the number of female staff in management positions in the RIKEN administration, can also help to guide RIKEN in its endeavor to improve the working environment for woman scientists.

The 6<sup>th</sup> RAC, like the 5<sup>th</sup> RAC, strongly believes that graduate students are an important ingredient of a vital scientific institution and we urge the central administration of RIKEN to develop an appropriate strategy to expand their number beyond the current 1200 students. First, a larger graduate presence will benefit RIKEN. Graduate students, by their energy, new ideas, and willingness to explore novel scientific terrain, enliven scientific communities. They also provide a valuable source of scientific manpower, particularly for young investigators whose wider reputation is not yet established enough to attract post-doctoral fellows. Second, RIKEN provides a superb training environment for research that should be used to the fullest extent possible within the Japanese system.

To increase the number of students, RIKEN can work out arrangements with local universities, as has been done at various Institutes, to facilitate graduate work at RIKEN or it can encourage joint appointments, as has been done at several Institutes. We also suggest that RIKEN consider forming a small, focused international graduate program

that would seek to bring students from all over the world to RIKEN for graduate education.

## **Extending RIKEN Relationships within Japan**

As the preeminent research institution in Japan, RIKEN has a responsibility to other scientific institutions and to the larger society. To serve this role most effectively, RIKEN needs to be more widely known within Japan, both as an international center of scientific excellence and as a benefactor of Japanese society, working toward improving the quality of life for all Japanese.

### *RIKEN and Japanese Scientific Institutions*

#### **Recommendation 1a: Strengthen Science and Technology at RIKEN**

- Through infrastructure and other means, extend the scientific relations of RIKEN with other institutions in Japan and abroad.

Over the last two decades, RIKEN has emerged as the leading scientific research institution in Japan in the physical and life sciences. From its position of leadership, RIKEN has much to gain from strengthening relations with universities and other research institutions within Japan; it also has much to offer them through a stronger working relationship. In as many ways as possible, we recommend that RIKEN seek to engage universities and other research institutions as partners and collaborators rather than as competitors.

One way to clearly signal RIKEN's interest in establishing such relations is by inviting experienced senior scientists or leaders from universities or other research institutions to join the External Advisory Committee that advises the President. This would have the effect of including them in RIKEN's deliberations, allowing them to give advice and to receive information about important developments at RIKEN.

Through the system of limited term contracts, most RIKEN scientists go on to other positions, often within Japanese universities. One of the valuable functions that RIKEN serves is as a training ground in which highly selected, well-funded young investigators

can establish themselves scientifically. As their scientific programs develop and they move into universities, they become agents of change within Japanese science, bringing to the universities the vigorous scientific culture characteristic of RIKEN. The movement of scientists between RIKEN and the universities is an important conduit by which relations with universities can be enhanced. We suggest that RIKEN encourage scientists who have left RIKEN to continue their relationship with RIKEN, perhaps by giving them special status as “RIKEN alumni” and including them on RIKEN mailing lists. By continuing to inform them about RIKEN and to involve them in its activities, they are encouraged to remain invested in RIKEN and can better foster relations between RIKEN and the universities.

A prime opportunity to establish scientific relationships with universities and other research institutions is through the large infrastructure projects which now will be operated as national, and even international, scientific resources. SPring-8 has already become such a resource. We note that over 12,000 investigators have carried out projects at SPring-8 over the last year or so. The BioResource Center is another example of a widely used resource. The Nishina Center for Accelerator-Based Science is now planned to be available for research to those outside RIKEN and we understand that the petaflop computer will also be operated as a major open-use resource. As a manifestation of RIKEN’s role in engaging others as collaborators, we encourage RIKEN wherever possible to include representatives from outside institutions in the governance structure of these projects. The Protein 3000 project, in which RIKEN scientists have taken a leadership role, is another highly successful example of scientific engagement in collaborative projects within Japan. We urge that other RIKEN facilities (the impressive NMR facility, for example), should be made available and easily accessible to outside scientists whenever possible.

**Recommendation 3: Increase RIKEN’s contributions to society**

- Enhance the translation of RIKEN discoveries into therapies by expanding clinical partnerships

A second area in which RIKEN can engage profitably with universities is through establishing relations with clinical scientists. If discoveries made at RIKEN relevant to health care are to benefit society they must be tested in the clinic. RIKEN cannot, and

should not, develop such facilities itself, but can develop strong relationships with clinical partners at Japanese universities and hospitals. The Research Center for Allergy and Immunology (RCAI) has established an apparently effective network of partnerships with a number of medical schools and hospitals in the Tokyo area. Others may be established through a Translational Research Center situated near the RIKEN CDB in Kobe. We urge the central administration at RIKEN to develop a strategy by which basic research at RIKEN can be most effectively coupled to translational and clinical research.

We note here with great interest the creation of a novel Molecular Imaging Research Center, presently under construction, that will allow RIKEN to apply to the life sciences and medicine its considerable expertise in research instrumentation, physics and chemistry. This new venture will present unique opportunities for the transfer of novel imaging techniques and reagents to users in life sciences research, the biotechnology and pharmaceutical industry, and clinical medicine.

Finally, the importance of increasing the number of students at RIKEN is discussed elsewhere in this report. We strongly recommend that RIKEN develop policies that would increase the number of graduate students from universities at RIKEN. This could be accomplished by joint appointments of RIKEN faculty at universities or by arrangements that allow students to work with non-affiliated RIKEN researchers. Such arrangements would seem to offer benefits to both sides – the universities are able to expand the number of outstanding faculty with whom their students can work, thus increasing their attractiveness to the very best students, and RIKEN is able to enrich its scientific community by increasing the number of students.

**Recommendation 3: Increase RIKEN's contributions to society.**

- Expand the educational activities that inform the public about science and RIKEN

**Recommendation 5: Nurture the exchange between scientific and humanistic cultures.**

- Encourage cultural events, such as those at Yokohama, throughout RIKEN
- Continue initiatives to educate the broader Japanese culture about scientific values and modes of operation and about science as a “human” enterprise that satisfies humanistic values such as curiosity, esthetics, and the desire to find meaning and structure in our lives and in the universe.

It is not enough that RIKEN is a valuable resource for the scientific community in Japan; it should also be a resource for the larger Japanese society to whom it is finally responsible. As President Noyori stated in his opening remarks, “RIKEN needs to make a strong contribution to society; and RIKEN needs to be respected by society for what it does.” There are many ways in which RIKEN benefits Japanese society:

- Economically, through the stimulation of industry that new technology brings;
- Educationally, through its training program for young scientists and its outreach programs to schools;
- Through better health care brought about by discoveries made at RIKEN;
- And through a better understanding of ourselves and the physical world in which we live, yielding to a better quality of life in Japan.

We encourage RIKEN to continue and to increase its interactions with the larger society of Japan. In particular, we urge RIKEN to continue and expand its educational role, so that the Japanese people might have a better understanding of science, both as a human enterprise and as a way of understanding who we are and what our place in the world is. Activities such as the RIKEN News, outreach into the schools, tours of RIKEN, and other activities that inform the Japanese people about RIKEN and about science are very important means of engaging the public. As part of this effort, we encourage RIKEN to pay particular attention to its educational and public relations activities, with the help of experienced outside consultants, if appropriate.

## Infrastructure and Budget

### **RAC Recommendation 1a: Strengthen Science and Technology at RIKEN.**

- Through infrastructure and other means, extend the scientific relations of RIKEN with other institutions in Japan and abroad.
- Carefully balance investments in large infrastructure projects with the need to protect small, laboratory based basic research.
- Where possible, engage in strategic planning to insure the optimal scientific output from the large, infrastructure projects.

The development, construction, and operation of large-scale instruments and infrastructures for scientific research have been an important part of RIKEN's mission and identity from the beginning. During the 1920s and 1930s, RIKEN was not only Japan's leading center for basic research, but was also a source of state-of-the-art scientific instrumentation for Japan's scientific community. The first cyclotron in Japan was built by RIKEN and today RIKEN scientists continue to be at the cutting edge in the design and construction of large particle accelerators. With the SPring-8 synchrotron radiation facility in Nishi Harima (originally a cooperation between RIKEN and the Japanese Atomic Energy Research Institute, JAERI), RIKEN has demonstrated its ability to build and operate a world-class research facility used by thousands of scientists every year. RIKEN owns and manages various other research infrastructures that are unique, such as the NMR park at the RIKEN Genomic Sciences Center (GSC) and the genotyping platform built at the RIKEN SNPs Research Center (SRC). Opening-up unique research infrastructures for outside use by scientists based at Japanese universities will considerably enhance the position of RIKEN within Japanese science and to counterbalance the perception – often unwarranted - that RIKEN is a research organization that is “closed” to outside scientists.

### *Research Infrastructures at RIKEN Today*

When RIKEN was restructured as an Independent Administrative Institution (IAI) in the fall of 2003, the construction and operation of large-scale facilities was included in the definition of the new organization's mission. Much of the prospective growth for the next few years is now linked to large-scale scientific infrastructure projects, notably plans to build a working free-electron laser and a 10-petaflop supercomputer. Both projects are

national efforts with significant funding and, especially in the case of the supercomputer project, a strong coalition of political support. These new infrastructure projects offer exciting scientific possibilities to RIKEN and, as we suggest in a preceding section, offer RIKEN an opportunity to provide a service for, and to establish strong connections with, other Japanese scientific institutions. Finally, both projects aspire to world leadership and will further strengthen RIKEN's international position. The 6<sup>th</sup> RAC thus strongly endorses the emerging role of RIKEN in providing large-scale infrastructure for the larger Japanese (and in some cases, the international) scientific community. The choice of RIKEN to develop these projects we believe is a wise one that represents a significant vote of confidence by the Japanese government in RIKEN.

For these reasons, RAC urges RIKEN to plan carefully a scientific strategy for the use of the new infrastructure projects, particularly for the super-computer project. To obtain optimal scientific productivity rather than just technological supremacy, RIKEN will need to give careful consideration to the scientific objectives to be achieved and to have a clear plan for establishing priorities for use of the supercomputer. Although we heard anecdotal evidence of ways in which the supercomputer might benefit RIKEN and other scientists, we did not hear a clear, well-articulated scientific rationale for the project. We strongly urge RIKEN to develop a scientific strategic plan for this and other projects.

#### *Large Infrastructure Projects: The Benefits and Risks*

In spite of the undoubted benefits of the new infrastructure projects, the 6<sup>th</sup> RAC expressed several concerns about the possible strains that they will create within RIKEN. The most important concern is that the new role of RIKEN not imperil or jeopardize the traditional role of RIKEN as the source of small-scale, innovative science in a variety of disciplines. As expressed earlier, we believe that the "core mission" of RIKEN is to nurture the creativity and open-ended curiosity of scientists in the DRI, the FRS, the Institutes and the Centers and that this mission must remain central to RIKEN. It is precisely the prospect of coupling the imaginative creativity of individual RIKEN scientists with state-of-the-art, enabling technology that makes the infrastructure projects so exciting.

An adverse practical impact of the large infrastructure projects may be felt in two ways. First, the administrative burden of developing such projects is considerable and may overload the capabilities and expertise of the senior administration of RIKEN. Second,

we are concerned that if the projects are underfunded, RIKEN will have to bear direct or indirect costs that will come have to come out of other budgets. It will be very important that not only development costs, but also maintenance costs, for the large infrastructure projects be fully funded.

### *RIKEN's Budget*

While Japan's science budget is set to expand further, the Japanese government by law has requested IAI's to decrease their baseline budget and staff over time. This has created a paradoxical situation for RIKEN and one that seems to favor large, government-funded infrastructure projects as a means of maintaining and expanding the organization's budget, while at the same time forcing RIKEN to out-contract management of research facilities to third parties in order to save costs and decrease internal staff. While we are confident of RIKEN's ability to compete successfully for large-scale funding of specific projects, these inevitably set expectations about time-scale and criteria for success that are often not well-aligned with scientific achievement. It is likely that large infrastructure projects will account for an increasing share of new funding at RIKEN. In terms of budget, these projects need to be evaluated carefully since operating costs may considerably impact RIKEN's future budget allocation, thus further reducing the funding available for curiosity-driven basic inquiry. Thus, dependence on large sums of money for limited times to achieve limited goals may lead to fluctuations and instability in funding that may be damaging to the long-term enterprise. The 6<sup>th</sup> RAC points to the Nishina Center for Accelerator-Based Science as an example of the enormous benefit gained from a long-term investment and sustained support over several decades. We respectfully request that the government very carefully evaluate the accomplishments of RIKEN and the impact of the current budget cuts on its continued success.

### **RIKEN's International Role: The Global Challenge**

Competition in the global economy increasingly depends on investing in the development of human and technological capital. In these terms the recent increased investment of the Japanese government in RIKEN can be seen as strengthening the foundation and technological foundation on which the future economy will grow. The investment has been extraordinarily successful. In a remarkably brief period of time,

RIKEN has not only become a leading scientific institution in Japan, but has increasingly achieved international status, comparing favorably with many of the leading research institutions world-wide. We believe that RIKEN now stands on the brink of prominence and leadership in the international scientific community. RIKEN is very aware of the global challenge and its possibilities; thus one of the Terms of Reference for the 6<sup>th</sup> RAC explicitly asks for recommendations to enhance RIKEN's visibility, strengthen its presence and to refashion it into an organization with a global outlook.

### *RIKEN's Presence in the International Scientific Community*

RIKEN has several strengths that distinguish it from other leading institutions world-wide. First, there is the strong sense of cohesion and common scientific purpose among the many parts of RIKEN, a sense that has been fostered and that has grown under the leadership of President Noyori. This may be contrasted with the Max-Planck Institutes in Germany, for example, which maintain a very high standard of scientific excellence, but which operate scientifically as independent, autonomous institutes. Second, it is very unusual to have a single national institution that has achieved such prominence, and has such extraordinary resources in both the physical and life sciences. In the United States or in Great Britain, for example, major life science research centers (NIH or MRC) are housed in separate institutions from those in the physical sciences. Having strengths in both areas is likely to be a powerful advantage for RIKEN in the future, as many believe that the intersection between biology and the physical and engineering sciences will be one of the next major frontiers. Third, as noted above, RIKEN encompasses within a single institution both large, state-of-the-art scientific facilities, and small individual laboratories of excellence, enabling it to participate in, and to lead scientific activities across a wide range of project types.

### *A More International RIKEN*

A major challenge will be to make RIKEN itself more of an international institution, so that barriers to the free flow of scientific ideas, technology and personnel between Japan and the rest of the world can be removed. We make several recommendations that address this challenge:

**Recommendation 2: Enhance the scientific personnel and culture of RIKEN.**

- Intensify efforts to recruit non-Japanese scientific and administrative personnel at both junior and senior levels.

RIKEN has set an important example for Japan in its efforts to recruit talented individuals from across the world. Currently, about 10% of its scientists are non-Japanese, compared to 1.4% at other institutions in Japan. The goal of 20% that RIKEN has set for itself is an important and appropriate one. In the global scientific marketplace, Japan will increasingly compete with institutions in other countries for talented personnel. Top-level scientists move ever more freely between different countries, as the top institutions compete for the best scientific personnel in an increasingly international marketplace. Several of the members of the 6<sup>th</sup> RAC, for example, have worked or are now working in countries that are different from their country of origin. As a more immediate example, we note that RIKEN has recently lost one of its most promising mid-level scientists to Harvard. We believe the RIKEN must be able to compete at this level if it is to maintain and enhance its role in the international scientific community. Although most of RIKEN's efforts to hire foreign scientists have been at the junior and mid-career levels, we believe that RIKEN should consider the possibility of recruiting prominent senior scientists from abroad, even at the Director level. The recruitment of a world-class senior person to RIKEN would send a very powerful signal to the outside world: a) that RIKEN is willing to compete with the best for talent; and b) that outstanding scientists want to come to RIKEN. We note that Singapore, for example, has attracted recent world-wide attention by recruiting several high-level scientists and scientific administrators from abroad.

Many of the Institutes and Centers at RIKEN are making imaginative efforts to make themselves more international, both by increasing international contacts and by increasing the number of non-Japanese scientists. We urge the central administration to give strong support for these efforts and to encourage the promotion of "best practices" among the Institutes and Centers, as appropriate. Among the notable initiatives that we learned of were:

- Summer courses that bring international staff and students to RIKEN
- Visiting Scholar programs that bring senior scientists from abroad to RIKEN for short periods of research

- Programs that bring foreign graduate students to RIKEN
- International conferences and workshops held at RIKEN
- Support programs for non-Japanese scientists
- Use of English in all scientific and administrative matters

The last of these is extremely important in helping RIKEN internationalize since language is a major barrier to communication.

**Recommendation 2: Continue to strengthen RIKEN scientific governance**

- The use of English for both scientific and administrative matters should be increased throughout RIKEN.

*Increase the International Visibility of RIKEN*

RIKEN does not receive the global recognition that it deserves. Its rise to prominence, especially in the life sciences, is relatively recent, so that it is only now beginning to be recognized. We believe that there are several ways in which RIKEN could improve its visibility on the international stage. As discussed above, a highly visible international recruitment would draw the immediate attention of the scientific world. We make several other suggestions below, including that of “branding”, and of making coverage in the international media a priority, again, with the help of outside consultants, if necessary. Perhaps the most important asset that RIKEN possesses in its effort to increase visibility, however, is the President himself. President Noyori presents himself as a vigorous, articulate and engaging leader, able to project a compelling vision of RIKEN and its mission. We suggest that he make several international trips a year in which he visits major cities and research institutions of the world, making himself available for speaking engagements, panel discussions and interviews. Among other things, he might call on members of the 6<sup>th</sup> RAC to help introduce him in appropriate places. We would be happy to do so.

**Recommendation 4: Enhance RIKEN’s visibility and international standing**

- Support and expand communications, using outside consultants if necessary
- Intensify international efforts to make RIKEN more visible
- Create a strong RIKEN “brand”
- Use the President as an effective international ambassador for RIKEN

RIKEN should make an effort, using its communications office and outside consultants, if appropriate, to increase its coverage in the international media, particular opinion-makers such as the *New York Times*, the *London Times*, *Le Monde*, *Die Zeit*, and also prominent and widely read scientific journals such as *Science* and *Nature*.

RIKEN should establish a stronger corporate identity, through standard identification, logo and other means. In particular, the name RIKEN should be associated with all Centers and Institutes. Finally, the President himself should actively undertake the role of international ambassador for RIKEN.

*RIKEN and Asia*

**Recommendation 3: Increase RIKEN’s contributions to society**

- Cultivate scientific relationships with other countries in Asia.

Japan currently has the strongest scientific enterprise of any nation in Asia and Oceania, and consequently has an opportunity to play an especially critical and responsible leadership role in its development. Asian science right now is on the rise – dynamic entrepreneurial, energetic and with large government investment. Many believe that within a matter of decades, the center of world-wide science may be in Asia. Japan, which has traditionally been oriented to Europe and the United States is in a position to be an important bridge between more established scientific centers and the new dynamism in Asia. RIKEN has an opportunity to make an especially significant contribution to this development by establishing strong links with other Asian/Oceanic institutions, by offering expanded training opportunities to young Asian/Oceanic scientists, and by promoting regional cooperation among scientists in specialized fields. Although several Institutes and Centers are engaged in important regional activities, we

urge the central administration of RIKEN to support and encourage these activities and to consider RIKEN-wide initiatives that will promote the development, growth and cooperation of science within the region.

## **APPENDIX: ADVISORY COUNCIL REPORTS**

RAC has carefully reviewed the summary reports and recommendations of all RIKEN Advisory Councils (hereafter ACs—while some of the ACs have adopted a particular name or acronym, we refer to them as ACs). We are especially impressed by the rising quality of these documents, which testify to continuing efforts at RIKEN to strengthen its advisory and evaluation system. Equally, the high degree of responsiveness by all parts of the RIKEN organization to these documents is exceptional.

In what follows, we provide brief summaries of the main findings and recommendations. Report summaries are listed in alphabetic order.

### **BioResource Center (BRC)**

The AC of the Bio Resource Center (BRC) noted with great satisfaction the substantial progress that has been achieved over the last two years compared to the situation at the first AC meeting. Progress has been remarkable, and the BRC is stronger and more solid than it had been only a few years ago. At the same time, the center has also expanded into a wider variety of research.

The director and his staff are to be congratulated for these achievements. In particular, the AC wishes to address its warmest congratulations to the founding director, Professor Moriwaki, for leading the RIKEN BRC so efficiently and for infusing a spirit favorable to the harmonious development of the center's activities. The AC also expresses its great satisfaction with the appointment of Professor Obata as new director. This will guarantee continuation of the same spirit of innovation and efficiency. During the AC meeting Dr. Obata provided precise and concise explanations of the general activities of the BRC and showed a firm grasp of the issues that BRC faces. It is clear that most of the divisions now have coherent projects and most of them are developing interesting, even outstanding research activities, which in many instances complement their service activities.

Specific suggestions by the AC included the following:

- With an ever-increasing and world-wide level of genomics research it is clear that the demands the national and international research communities will place on the

RIKEN BRC are likely to increase dramatically in the next few years. For this reason, the BRC must be prepared for a dramatic expansion of its activities. New technologies and increased efficiencies will be needed to meet increased demand.

- The BRC should be prepared to introduce and further develop new scientific technologies as they appear in the near future. For example, several projects with the aim to generate many new mutations in mice (ideally one in every gene of the genome) are being undertaken on a world-wide basis, including in Japan, and these projects will have a profound impact on the activities of the BRC. Other important techniques, including *in vivo* and molecular imaging at the single cell level will also develop. The AC hopes that these techniques will be fully exploited at the BRC.
- The BRC is to be congratulated for its efforts to develop international collaborations with similar institutions in neighboring Asiatic countries. These efforts will have a strong and positive influence on the progress and importance of the RIKEN BRC and will enrich the various resources as scientific research progresses in these countries. At the same time, they will also increase the load of new responsibilities at the RIKEN BRC.
- The AC considers that there is a need for the hiring of young, active research staff, to maintain and improve current activities at the BRC.
- It is finally suggested that a system of internal self evaluation be established.

### **Brain Science Institute (BSI)**

BSI is now in the first rank of internationally recognized neuroscience institutes in a global perspective. The international visibility of BSI and many of its scientists is high and the achievements in many different areas, like developmental neurobiology, learning and memory, and disease mechanisms are very impressive. One reason for the high impact of BSI is an effective recruitment of young excellent scientists into BSI, including a number of women scientists. Equally important, outstanding young team leaders have been promoted to group directors. A special section for the development of novel cutting edge approaches has been very successful and has attracted due attention, as has the excellent "Research Resource Center". The latter provides advanced standard technologies (e.g. mass spectroscopy, gene arrays, electron microscopy etc.) that can be utilized by all BSI researchers. A comparatively large number of foreign scientists (20%) have been attracted to BSI, which no doubt is due to the outstanding facilities and working conditions, combined with a well developed

system to assist and help the foreign researchers to overcome the practical obstacles that will meet a foreigner in Japan.

Specific recommendations included the following:

- BSI should continue international recruitment; recruitment at leading positions within BSI should be a priority.
- Scientist recruited into the BSI should expect their position to last only for a limited time, typically five to ten years, and then to transition to other positions in academia, the public sector, or industry. However, to provide stability it is desirable to hire selected group leaders for a more extensive period of time. Long-term staff continuity is also crucial to maintain the high quality services of the “Advanced Technology Development Center” and the “Research Resource Center”.
- BSI should develop a creative and realistic strategic plan.
- BSI laboratories should be encouraged to increase the level of funding from external sources.
- BSI should minimize the effects of the anticipated reduction in budget on the individual laboratories.
- Administrative and scientific meetings within BSI should be held in English. All major administrative documents should be available in English.
- We encourage BSI to further stimulate training activities of post docs and graduate students, through initiating and organizing workshops, journal clubs, lecture series, and retreats.

BSI has recently taken the leadership within Japan to develop the Japanese node within the “International Neuroinformatics Coordinating Facility”. This is an international organization, initiated by Global Science Forum of OECD, with the purpose to develop neuroinformatics databases extending from gene to disease and behavior, and also to model the complex processes of the brain. It is financed by annual contributions from Japan, United States and a number of European countries.

### **Center for Developmental Biology (CDB)**

The AC members were impressed by the overall high quality of scientific research at CDB. In its five years of existence, the CDB has rapidly and successfully established a series of creative and ambitious research programs. With nearly hundred publications in

2005 alone, many of them in high-impact journals, the research output is remarkable. The CDB has made good progress in establishing itself as a premier institute in the field of developmental biology, and may in fact be one of the largest institutes devoted to this field. The CDB is now attaining recognition as one of the leading developmental biology institute in the world. This has been primarily achieved through the reputation of the Director and Group Directors and by the excellent publication record of the center. In terms of quality of resources, research and ambition, the CDB is on par with other leading developmental biology institutes. The fact that this has been achieved in a short period of time indicated that the CDB has the potential to become one of a handful of elite developmental biology institutes worldwide. We also note that CDB has launched a new Asian-Pacific regional initiative to improve interactions among developmental biologists in the region.

Specific recommendations included the following:

- Staff turnover is vital to the future development of the CDB and we recommend that the center devises a formal and transparent system of staff turnover, while maintaining appropriate discretionary authority of the Director.
- The CDB should continue its efforts to attract the best graduate students and to promote PhD level training.
- Young scientists at the institute should given appropriate opportunities to present their own work and ideas.
- We recommend that CDB continues its efforts to recruit both female and foreign scientists in team leader or group director positions.
- We suggest the creation of “returnee fellowships” for Japanese scientists working abroad.
- Internal reallocation of funds from large and established (i.e. group director) laboratories toward new activities is a potential way to keep up the dynamic evolution of the center. To this end, full discretion over funding by the director is essential.
- The AC agreed that a human tissue stem cell research is one possible program to be added to CDB’s present activities.
- We suggest that RIKEN provides direct support to the Office for Science Communication and International Affairs.

In conclusion, we are high impressed with the progress made at the CDB in the few years since its inception.

## **Frontier Research System (FRS)**

The committee strongly endorses Director Tamao's concept of the FRS mission and expects new fields of science to emerge and grow within the FRC. The Frontier Research System, in our opinion, may well be one of most efficient and cost effective mechanisms to promote new research areas at RIKEN.

It is suggested that more flexibility be provided in determining the length of a project when it is initiated. Duration need not necessarily be increased, but the possibility should be provided for in cases where it is found advisable or necessary. We further recommend pursuing the possibility of establishing an improved FRS structure so that it can focus on its primary mission of fostering innovative research in a more visible mode of operation. The AC feels that as concerns the project selection process there is still considerable room for improvement. In particular, the leadership of the FRS director with respect to project selection should be strengthened. Given the specific nature of the FRS, a special "search committee" reporting to the director might be one possible approach.

Specific recommendations included the following:

- The FRS should develop a specific action plan to increase the number of non-Japanese scientists.
- We encourage FRS to conduct a long term follow-up survey on the career paths of former project members and keep track of their career development. Further, we suggest that the number of full-time staff in the FRS Career Support Center be increased. FRS should also strengthen the alumni organization of FRS (and RIKEN as a whole).
- More efforts to increase public awareness on research results are necessary in order to enhance RIKEN's global role and its contribution to society and culture.

## **Institute Laboratories (ILs)**

The Institute Laboratories (ILs) are the historic core of RIKEN. While their relative size and influence has decreased over the past few years, the ILs remain crucial to RIKEN's overall identity. The ILs have been the birthplace for many new centers and also remain one of the most dynamic parts of the entire RIKEN organization

The introduction of the “RIKEN Science Council (RSC)” and “Distribution Committee for Tenure Track Positions” is fully appreciated. At the same time, for the best interests of the whole of RIKEN, we recommend that chief scientists have an appropriate degree of representation within the RSC. The AC recommends that every effort be made to maintain a high degree of coherence in the selection of new IL chief scientists.

Specific recommendations included the following:

- We strongly endorse joint appointments, but also caution that these be monitored carefully so that the interests of RIKEN are not adversely affected.
- The introduction of the associate chief scientist (ASC) position will enhance the range of research areas and encourage young scientists, but great care is advised in the operation of this new program and its apparent linkage to a reduction in the total number of chief scientists.
- We support attempts to utilize talented individuals who are past retirement age and welcome the development of more detailed plans in this direction.

### **Genomic Sciences Center (GSC)**

The RIKEN Genomic Science Center (GSC) has made outstanding contributions to world science over the past five years and has achieved international recognition as a result. It is one of the few institutes in the world in the position to research the relationship between genetic programming and phenotypic variation in humans and model organisms.

Adapting to the post-genomic research environment is something all large genome institutes are now facing. Worldwide research is now building on the large genome-wide datasets that have already been collected. In this competitive environment it is important for genome institutes to integrate their activities to continue to deliver outputs that are unique and only possible with their resources. Under the leadership of Professor Sakaki, GSC has recognized the importance of an integrated research strategy, described as “From Elements to Systems”. The AC strongly supports this objectives and a more integrated program of work.

We believe that GSC has all the components required to continue to build on its reputation and success to become a truly world leading institution. However, with the

very rapid progress and continuous change in the field of genome science, it is essential that large institutions and programs are able to dynamically adapt and to take advantage of new opportunities and modify existing programs to ensure they remain internationally competitive.

Specific recommendations included the following:

- While the outcome of each project is great, the AC recommends increasing efforts to identify where existing technical and intellectual strengths of the different projects might be exploited together to deliver unique scientific value.
- Genomic science is data-rich, making integrated research dependent on data integration and access. We believe that GSC needs to significantly increase its bioinformatics resources in a way that stimulates and supports inter-project interactions and data analysis.
- The AC believes that Japan will maximize the benefit from its investment in GSC as GSC maximizes its participation in relevant worldwide scientific communities.
- We regard maintaining a genome sequencing capacity as being in the Japanese national interest and strongly recommend that it is supported at GSC.
- Better integration with the SNPs Research Center will help maximizing the output from these expensive government funded programs.
- The AC believes that the best route to drug development for GSC will be to develop strong genome wide activities, making use of its technical expertise, which can be translated in a strategic manner with appropriate partners.

### **Plant Sciences Center (PSC)**

The AC members were impressed with the outstanding contributions that PSC has made to international plant research. While the first phase of RIKEN PSC (PSC1) had a strong focus on the development of technologies and model organisms, PCS2 now provides an opportunity to focus on key plant models and exploit functional genomics technology platforms to understand the molecular mechanisms of plant production. This refocusing is consistent with the new national initiative "Green-Techno Plan" (Green Technology for the Future of Human Beings), and fully aligned with other international initiatives. Director Shinozaki is leading PSC2 by focusing the research on plant metabolic systems and its applications. This new direction promises to provide important insights into plant functions that will help to improve the productivity of crops and trees.

The research plan as outlined in 2005 report is well structured, ambitious but realistic, and forward looking. This research will be carried out by expert scientists with the support of established technologies and new infrastructure platforms.

Specific recommendations included the following:

- The organizational development of PSC2 should be facilitated in order to meet the goals of the national "Green-Techno Plan". Consideration should be given to the development of additional and/or new career tracks for young scientists to foster their independent growth.
- Special efforts should be made to recruit excellent and high-profile young group and team leaders from outside RIKEN. Director Shinozaki should also consider promoting excellent team leaders with proven track records to group leader positions.
- The AC supports Director Shinozaki's decision to facilitate the transfer of basic research results into applied crop biotechnology. Such a pipeline will require ongoing monitoring of activities to assure that the research remains focused on the longer-term goals of PSC2.
- The AC strongly supports the development of new methodologies, but also cautions that they must remain closely connected to the biological questions and applied problems.
- The AC supports Director Shinozaki's decision to establish a director's fund. This discretionary fund should be invested into new strategic initiatives and used for the development of technology platforms to achieve the stated goals.

Under the guidance of Director Shinozaki and together with the RIKEN leadership, PSC2 can realize the vision of "an organization with a strong international reputation for excellence as Japan's leader in plant research". The AC is convinced that PSC2 plant research efforts will make significant contributions to society and therefore looks forward to review the implementation of the long-term strategic research plan and progress towards the 5-year goals during its next meeting.

### **Research Center for Allergy and Immunology (RCAI)**

The AC is highly impressed with the rapid development and high quality of the research accomplishments of RCAI since its occupancy of the new RIKEN Yokohama campus facilities. The senior investigator-led groups have taken full advantage of the excellent

facilities that this new center offers. Most importantly, the younger investigator-led groups are also thriving in this favorable environment. RCAI's central facilities provide rapid services of high quality to RCAI scientists. Strategic investments in leading-edge technologies and approaches, such as single-molecule imaging and high through-put genomics, are paying off handsomely and will continue to do so. Access to these outstanding core facilities empower smaller research groups by speeding up their internationally competitive research projects. The strengths of the basic research enterprise places RCAI in a strong position for future investment in translational research and to serve as a source infrastructure for collaboration with clinical research centers. The RCAI International Collaboration Award Program has enhanced international awareness of the Center and, notably, collaborative results funded by this innovative scheme are being published in high profile international journals. We are supportive in general of the Center's future plans, an excellent example of which is the dedicated development of a mouse model with a functional human immune system. The difficulties of this endeavor notwithstanding, we believe the investment in this model promises to significantly enhance RCAI contributions to immunological research related to human diseases. In addition to an appreciation of the judicious administrative style of the RCAI Director, Dr. Masaru Tanaguchi, we are impressed by the rapid and appropriate RCAI response to the AC's scientific evaluations and advice. Finally, we congratulate the Japanese government and RIKEN for its vision and support of this new scientific center of excellence. Given the overall mission of the center, RCAI should further strengthen its capacity in basic research—as opposed to applied development—in the field of common allergies.

Specific Recommendations included the following:

- Given the overall mission of the center, RCAI should further strengthen its capacity in basic research—as opposed to applied development—in the field of common allergies.
- We recommend that RCAI create a small Clinical Advisory Council to advise the Director on the general strategic issue of how to build a credible translational research program, as well as practical decisions related to individual projects.
- We believe that RCAI should build on recent success and strengthen its activities in the field of single-molecule and *in vivo* imaging.
- We endorse RCAI's plan to make a significant investment into the development of novel mouse models reconstituted with a human immune system, fully recognizing

that considerable time, manpower, and funding will be required to develop mouse models that can mimic a human immune system with sufficient accuracy.

- We strongly support RCAI's efforts to build effective networks with clinicians in the areas of human primary immunodeficiencies and childhood allergies. Both initiatives are well-conceived and of strategic importance to the center.

### **SNPs Research Center (SRC)**

Since its foundation in 2000, the SNP Research Centre (SRC) has established itself as world-class centre for human genetics. The SRC has been a pioneer in the development and application of new methodologies for identifying the genetic factors underlying susceptibility to major human diseases. Their research in disease genetics has had a significant international impact. The SRC is unique in Japan in its capacity for the analysis of genetic variation on a genome-wide scale (genotyping), which is the principal methodology for these studies. The center's structure allows it to respond rapidly and in a cost-effective manner to national needs for large-scale infrastructures to support collaborative research in the areas of genetics and genomics applied to human health.

The SRC has played the largest role of any single laboratory worldwide in data generation for the recently completed Hapmap project, one of the principal international efforts in human genetics to arise from the sequencing of the human genome. The goal of the project is to provide key information on common genetic variants in different human populations. The results of the Hapmap project have provided an important new tool that is already being widely used worldwide for disease studies and other areas of genetics research. The SRC is well-positioned to exploit these results through its genotyping capacity and its role as the center for disease gene identification in the Japanese Biobank.

The Japanese Biobank is a national program to collect patient samples for the study of the genetic basis of 47 diseases with a major public health impact in Japan through an extensive clinical network that has been established for this purpose. The genetic information from the SRC's research will provide the basis for genomic and other biological investigations of these diseases. This will be undertaken partially within the SRC and partially in collaboration with other laboratories nationwide. To this end, the SRC has established a collaborative network which involves groups in 15 Japanese

universities and research organizations. The center has several projects that are focused on the identification of genetic markers that could be used in a clinical setting to predict individual differences in response to therapy and adverse drug reactions. The center intends to pursue applications of these results through the Biobank clinical network and other clinical collaborations, and is developing technology for genotyping of such markers in a clinical setting. The SRC is also engaged in collaborative efforts in disease genetics with other Asian countries. In the future, it intends to extend these collaborations to Middle East and Eastern European countries.

The AC gave a highly positive evaluation to the SRC's activities. Among the Council's specific recommendations, perhaps the most important one is a change of the Center's name to more accurately reflect its research activities. As these principally involve the application of genomic methodologies specifically to human disease, the Advisory Committee suggested that the "RIKEN Center for Genomic Medicine" would be an appropriate name for the center.

### **RIKEN SPring-8 Center**

The committee appreciates the creation of the RIKEN SPring-8 Center and fully supports the construction of XFEL. The combination of a storage ring source with the XFEL on the same site will provide RSC scientists with a considerable advantage. However, considerations should be made as concerns the necessary manpower for construction, otherwise there is a real danger that construction work will negatively impact upon the research activities of the institute laboratories at the center.

We have been highly impressed by the research activities in the three institute laboratories at the center, specializing in physical science, material science, and biology. Proper continuing support for these activities is important. Further, we believe there are considerable opportunities for growth and recommend that research activities be expanded at an appropriate time.

Distance remains an issues and the committee recommends that, to the extent possible, members of the RSC should spend a significant fraction of their time on the SPring-8 campus. Other efforts to be strengthened include the promotion of collaboration within

RIKEN as well as with laboratories outside Riken. Further, continuing attention should be paid to network projects linking synchrotron radiation researchers.

### **RIKEN Nishina Center for Accelerator Based Science (RNC)**

The accelerator group lead by Dr. Yano continues to make outstanding progress toward the completion of the RIBF Phase I accelerator complex. The AC congratulates the accelerator team for having achieved a “major milestone”: the successful operation of all six magnetic sectors of the world’s largest cyclotron, the SRC. Also, BigRIPS will be the world’s most advanced fragment separator when it is finished. While considerable work is necessary before the system will be ready for initial experiments, the present schedule—which calls for first beam in December 2006— appears realistic, if certainly ambitious.

The facility has considerable scientific potential and is well on its way to becoming a world-leading center in the field of RIBF science. Overall, the new centre has been established in accordance with recommendations of the AC report of 2004. At present, costs for Phase II instrumentation are estimated at 5.8 Billion JPY to be spent during 2007-2010. Given the importance of the science to be addressed and the complexity and scope of the tasks ahead, the requested funding appears reasonable.

The allocation of research time at RIBF should be based on scientific excellence with no distinctions between “inside” and “outside” users. This is an important basic principle for any use policy at major international megascience facilities. In order to optimize scientific use, and thus scientific output, continuing consultation with the international user community is essential. This process would ideally include the following:

- an enlarged AC with additional expertise that makes recommendations not only on RIBF physics but also on the RIKEN-BNL and RIKEN-RAL programs;
- a Program Advisory Committee with recognized experts in charge of priority setting and evaluation of research proposals;
- a Scientific Policy Committee that provides a direct voice to the users of the facility and to important collaborators in the university sector.

RIBF is an important and unique international scientific resource. It is important that its use is optimized internationally and especially with respect to Asian countries.