

REPORT OF THE 11TH RIKEN ADVISORY COUNCIL (RAC)

28 November 2019

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EXECUTIVE SUMMARY

The 11th meeting of the RIKEN Advisory Council (RAC) was convened on 25–28 November 2019 at the InterContinental Tokyo Bay Hotel.

We commend President Hiroshi Matsumoto for his ongoing reform efforts, which have already had a substantial impact in more closely aligning RIKEN’s world-class research capabilities with national priorities in Japan. New initiatives, such as the Hakubi Fellows and Kato Sechi programs for attracting talented young scientists and enhancing diversity, are key to ensuring RIKEN’s tradition of scientific excellence is carried forward into the next generation. The renewed emphasis on responsiveness to societal demands, promotion of technological innovation, and closer, more interdisciplinary collaborations, within and outside RIKEN, are all important to maintaining the Institute’s high standing in the scientific community. Ongoing measures such as modernization of the information technology infrastructure and data management systems are valuable and timely. The need to respond effectively to Japan’s new midterm plan for science and technology, changing employment conditions, and national economic priorities, presents new challenges in both strategy and implementation. We were impressed by the proactive measures that RIKEN has undertaken in the face of these new challenges under President Matsumoto’s leadership, and wholeheartedly endorse the sentiment he expressed in opening the 11th RAC meeting: “Reform is nothing without action.”

President Matsumoto asked RAC for its opinions and recommendations on RIKEN’s research strategies, management and performance, under the following terms of reference.

TERMS OF REFERENCE

1. The 11th RAC is asked to evaluate RIKEN’s responses to the recommendations submitted in the 10th RAC.
2. The Fourth Mid- to Long-term Plan (FY 2018 to FY 2024) was formulated in order to realize the RIKEN Initiative for Scientific Excellence (RISE), which establishes policies for the objective of producing research achievements of the highest international standards. RAC will review RIKEN’s progress in the following areas related to operations and will be asked to propose ideas for further improvement.

- 1) Strengthening of management functions and advanced research system
 - 2) Development of human resources for research
3. RAC is asked to look over the reports from each AC and give observations with respect to the following activities. We also ask RAC to suggest research strategies that will allow RIKEN to continue to fulfill its role as a world-leading institute.
- 1) Promotion of strategic R&Ds to address national and societal needs
 - 2) Development and operation of research infrastructure
 - 3) Development and creation of new fields of science
 - 4) Promotion of returning the benefits of research to society through the partnerships with other organizations
4. RIKEN plans for the establishment of a new company that plays the following roles.
- 1) Licensing of technology
 - 2) Support for venture companies
 - 3) Promotion of collaborative research
 - 4) Co-creation activities with industry

RAC is asked to provide advice on how to strengthen RIKEN's co-creation activities with industry, including consideration of strategies to be pursued by the newly established company.

SUMMARY OF PROGRESS

RIKEN continues to maintain its reputation for excellence within the international scientific community. Impressive new initiatives in artificial intelligence research, high-performance computing, and interdisciplinary collaboration will lend further support to RIKEN's mission to conduct leading-edge science that is responsive to societal needs. Prominent recent breakthroughs, from resolving the structure of the photosynthesis II molecular complex, to identifying new approaches to nuclear waste disposal, to the development, licensing and clinical testing of artificial adjuvant vector cells (aAVCs) for cancer treatment, further consolidate RIKEN's standing. Ongoing reforms in information and communications technology and data management should help ensure that RIKEN is well positioned to pursue research initiatives involving organization-wide interdisciplinary collaborations and massive datasets. The 11th RAC commends RIKEN's leadership and scientists for continually setting, and exceeding, the standard for science in Japan.

TOR 1: RIKEN RESPONSES TO 10TH RAC RECOMMENDATIONS

In evaluating RIKEN's response to the recommendations of the 10th RAC, we have focused on Terms of Reference 2–4 and our seven Key Recommendations, as detailed below.

Response to TOR 2: R&D strategy

- *RIKEN-wide programs in important areas are positive initiatives that provide avenues for synergistic cooperation between centers.*

Development of avenues for synergistic cooperation between Centers remains a challenge, although the new Engineering Network is a notable positive development in this effort. We strongly recommend similar network building efforts in areas such as chemistry, data science, and computational applications in life sciences, especially neuroscience.

- *To develop its contribution to biomedical translation we recommend that RIKEN consider the appointment of a dedicated Director of Clinical Translation.*

The creation of a new directorship in clinical translation is a positive step and should contribute to RIKEN's success in this important new focus.

- *RIKEN's accelerator physics program has gained international renown. Funding of its plans for expansion should be seriously and sympathetically considered, within funding constraints.*

RIKEN has responded to the RAC recommendation on the expansion and maintenance of the Nishina accelerator program. We note that the present facilities are yielding world-class results, including the historic synthesis of the new chemical element nihonium. However, we urge that funding of any upgrades to the accelerator should not come at the expense of reducing funding in other areas of high-quality research. Additionally, RIKEN must always keep in mind opportunities for and the value of international cooperation, weighing the convenience and prestige of national infrastructure against the efficiencies and prospects for enhanced collaboration that come from shared use of international facilities.

- *Data science research represents an important and timely new investment for RIKEN.*

The establishment of the Center for Advanced Intelligence Project (AIP) and the reform and rationalization of RIKEN's information and communication technology systems are excellent responses to the need to build capacity in the areas of artificial intelligence and data science. RAC welcomed these developments in this important field. The rapid growth of AIP to nearly 900 full-time and visiting staff has been made possible through cross-appointment of university faculty. While this may pose challenges for the long-term stability of AIP, forging stronger links within the academic community across Japan is a valuable contribution. Moving forward, RIKEN might look at similar initiatives elsewhere, such as the UK's Alan Turing Institute, for models of success at the national level. Cooperation with other national research institutions in Japan, such as the AIST AI Research Center and the Advanced Telecommunications Research Institute, could enable RIKEN to take the lead in the

effort to break down institutional boundaries in this important field. Research in artificial intelligence aimed at modelling or emulating the function of the human brain would benefit from a wider dialogue on the organization and working of the human mind, through interaction with experts in such areas as psychology, social sciences and cognitive science.

- *Translational research in physics, chemistry, materials science and information sciences should be carried forward within the paradigm of matching “seeds” to “needs,” which might best be coordinated by the Cluster for Industry Partnerships (CIPs), for example.*

RIKEN is to be congratulated for its new efforts in translational research, though these are in their infancy and need careful nurturing. Initiatives such as RIKEN Innovation Co. Ltd. and the Cluster for Science Technology and Innovation (CSTI) Hub have the potential to facilitate the translation RIKEN’s intellectual property into outcomes of benefit to society. The increased number of partnerships with Japanese universities and the provision of access to RIKEN’s large facilities for university communities are welcome components of RIKEN’s strategy, as are the expanded partnerships with industry. We encourage RIKEN to continue to explore collaboration with international industry partners, including in areas other than the pharmaceutical industry, which could also be of immense benefit to both RIKEN and Japan.

Response to TOR 3: Research management, scientific excellence, S&T hub, mobility and diversity, fostering leaders

RIKEN has made progress in addressing the recommendations of the previous RAC, especially in providing more efficient and effective administrative services, in promoting exchanges and discussions with international organizations (particularly the Max Planck Society), and in encouraging interactions among and mobility of younger staff.

- *Any change in the proportions of indefinite and fixed-term employees must be undertaken to ensure that the changes deliver maximum benefits to both RIKEN and its staff, which will enhance prospects to recruit and retain high quality personnel.*

RIKEN’s response to the changes in Japan’s labor law require careful management and a delicate touch. RAC understands some of the constraints on freedom of action but it urges RIKEN to find ways to comply with the law while preserving flexibility and the highest quality in the conduct of research. It was unclear to us whether the current plan for the dramatic expansion of the percentage of indefinite-term employees has been fully thought through, and we urge RIKEN to thoroughly and critically review this plan.

The turnover of younger employees can be beneficial to both research organizations and young researchers, fueling the rapid evolution of scientific fields and priorities,

but also providing training and opportunities for young researchers to build their skills and scientific output before moving on to positions in the universities and elsewhere. We acknowledge the value of indefinite-term appointments to technical staff with transferable or highly specialized skills. However, we advise that great care be taken in increasing the total percentage of indefinite PI and research scientist positions within RIKEN. Individuals hired to permanent posts should be chosen on the basis of their capacity and willingness to work across a broad and unpredictable range of applications and research topics. Similar decisions have been faced by research institutions in other countries, particularly in Europe, which may provide models for how to comply with legal requirements while maintaining flexibility in employment.

- *Introducing the new position of “innovation designer” shows promise as a means of extending RIKEN’s capacity in these areas as well as an important human resource development activity within Japan.*

RAC expressed concern about the lack of diversity in the first complement of Innovation Designers, as was recommended by the 10th RAC. We have yet to see an impact of this program and look forward to tangible contributions by the Innovation Designers in the near future. It is essential that their outputs and impact should be measurable, or at least visible. We do not recommend that further appointments of Innovation Designers be made until the value to RIKEN of this program becomes clearer.

- *Technological innovations developed by the Institute should be exploited for the benefit of innovation and commercialization, consistent with President Matsumoto’s new vision for RIKEN’s social role.*

We note in particular the establishment of RIKEN Innovation Co. Ltd, which is intended to facilitate innovation, commercialization and collaboration with industry. Our detailed assessment of this initiative follows in TOR 4, below.

- *RIKEN should accelerate its efforts to pursue partnerships with Japan’s universities. It also serves as a science and technology hub for collaboration with industry, which advances the development of innovation emanating from its fundamental research.*
- *We encourage RIKEN to continue to develop capacity in its engagement with both the academic and industry research communities, through R&D partnerships, infrastructure services, and arrangements for the development of its intellectual property.*

RAC is favorably impressed with RIKEN’s continuing efforts to engage with academic and industry partners in Japan and other countries.

- *RIKEN has made some progress in attracting outstanding researchers from other countries, but it would benefit from greater effort to recruit internationally, especially female scientists.*

Hiring of international researchers and female scientists appears to have stagnated and

to be area in need of significant improvement. Further efforts are needed to overcome systemic barriers impeding the recruitment and retention of foreign and female researchers. (see Key Recommendation 1 and Appendix).

- *Expanding its collaborations with researchers and institutions in other countries will further enable development of new ideas for mutual benefit.*

Response to TOR 4: Research addressing societal problems

- *We suggest that these objectives (clinical studies and/or pre-clinical drug development) should be advanced through strategic partnerships with leading academic institutions in the area of biomedical R&D.*

RIKEN has had several notable recent successes in its biomedical R&D efforts, such as the development of artificial adjuvant vector cells for cancer therapy. The establishment of RIKEN Innovation Company (RIC) should provide new mechanisms for enhancing translational research.

- *In the context of both the life sciences and the physical sciences, the new concept of an “Innovation Designer” position could play a crucial role in transforming RIKEN’s research output into new medicines and technologies.*

See relevant section in Response to TOR 3, above.

Response to Key Recommendations

1. Strategic plans for realizing our vision for RIKEN’s future (KR2)

- *We encourage RIKEN to develop a comprehensive strategy on the basis of a substantial analysis of its strengths, weaknesses, opportunities and threats.*

The SWOT analyses from the AC reports for individual research centers and infrastructure facilities were very informative. However, how RIKEN utilizes these internally to develop comprehensive strategy at the organizational level was not immediately clear.

- *In addition to learning from the experience of other organizations, RIKEN should take fuller advantage of an under-utilized resource: the perspectives and energy of younger research staff.*

It was unclear from presentations at the 11th RAC the extent to which younger staff, especially junior scientists, have opportunities to express views and influence RIKEN strategy.

- *We urge RIKEN to focus its efforts on making a compelling case for increased support to enable it to fulfill its opportunities and responsibilities to contribute to Japanese science and technology, for the benefit of society.*

We congratulate President Matsumoto and RIKEN leadership for stabilizing the institute’s budget, which had followed a concerning downward trend in recent years.

However, the slight increase in the FY2019 budget falls well short of what is needed to maintain the excellent research in the existing strategic research centers and to capture new scientific opportunities as they arise. We most strongly endorse RIKEN's efforts to persuade government funders to provide enhanced support to RIKEN, not only to maintain and realize the full potential of RIKEN's production of high-impact science, but also to support its work in inspiring young talent and accelerating societal impact.

2. Reform of personnel system / streamlining of administration (KR3)

- *We caution that such fundamental reforms (proportion of fixed/indefinite term employees) need to be implemented with an eye to long-term institutional effects. Care must be taken to ensure that providing longer-term security to its best scientists today does not limit its options for attracting and retaining the best scientists in the future, especially female researchers.*

See relevant section in Response to TOR 3, above.

- *We are concerned that the proportion of administrative staff at RIKEN is much higher than the norm in other countries (typically 5–8% of salary costs).*

We recognize that definitions, norms and job functions for administrative staff differ from country to country. Although the ratio of administrative to scientific positions at RIKEN is high by international standards, we did note that in their presentations young RIKEN scientists uniformly praised the support they received from administrators.

3. Gender balance (KR4)

- *While we acknowledge its efforts in establishing diversity programs, and its goal to increase the percentage of women in management positions by 2018, a much stronger effort is required to achieve a fundamental change in gender balance.*
- *We strongly recommend that all appointment and selection committees comprise a healthy balance of women and men, including, when necessary, individuals from outside RIKEN. We strongly recommend that each Advisory Council include at least one female member.*
- *Support programs for family care, career development, better work environments, onsite childcare, and the establishment of a Diversity Office are all welcome initiatives, but continued attention must be paid to transforming the Institute's culture at the highest levels and throughout the organization.*

The gender imbalance remains a significant problem at RIKEN, made even more urgent by the Cabinet's push for the empowerment of women in Japan. See Key Recommendation 1 and the Appendix for the detailed views and recommendations of the 11th RAC.

4. Attracting and supporting global talent (KR5)

- *Given its international standing and its excellent resources and facilities, we believe that even greater numbers of the most talented scientists could be recruited to RIKEN.*

See relevant section in Response to TOR 3, above.

- *In support of these efforts, we reaffirm the recommendation of the 9th RAC that RIKEN make English its official language. While challenges will inevitably arise in communications, particularly with other branches of Japan's civil service, this transition is necessary to making RIKEN a truly international workplace.*

We note with concern reports that communication in English has decreased at some centers. We once again emphasize the importance of making English the working language of RIKEN.

5. Effective communications (KR6)

- *RIKEN should develop comprehensive strategies for communications using social media platforms. Scientists should engage with the public through these media, and RIKEN should educate and support scientists in public engagement activities.*

Social media are critically important for effective public communication. More efforts are needed to increase exposure across key online media, in both Japanese and English. RIKEN should investigate reasons for the currently small social media audience for the institute's communications. By way of comparison, the Max Planck Society Twitter account has nearly 150,000 followers.

- *RIKEN should seek to further develop its mutual communications with governmental bodies, to promote its mission and gain better insight into government agendas and constraints. Similarly, RIKEN should continue to explore and cultivate industry research interests and developmental objectives.*

While this was not addressed specifically at the 11th RAC meeting, it remains an important area for ensuring RIKEN's interests receive sufficient attention from key decision makers.

6. Presentations at future RAC meetings (KR7)

- *Include a broad overview of the work of the centers, the technical platforms, chief scientists and the new Pioneering Research Cluster, in future presentations to RAC.*

The presentations this year were very informative, although in many cases slide

designs were excessively dense. We do ask that at future RACs important data, such as employment numbers and trends broken down by position, age, gender, discipline, etc. should be provided in a uniform format.

- *Include presentations by young researchers, including women, so as to give RAC a full impression of RIKEN's scientific work.*

The presentations by young scientists were a welcome addition to this year's RAC. In future meetings, young presenters should be encouraged to remain for discussion with members of RAC. All three presenters were impressive and provided useful insights into the experiences and challenges for younger generations of scientists at RIKEN.

TOR 2: OPERATIONS AND IDEAS FOR FURTHER IMPROVEMENT

2.1 Management and research systems

The newly reorganized Cluster for Pioneering Research (CPR) continues RIKEN's tradition of bottom-up research in novel fields. The CPR's work is intended to lead to new breakthroughs in science and technology and support innovation, both through specialized research approaches and interdisciplinary collaboration. Top-down directed research also plays critical roles in RIKEN, allowing the Institute to pursue focused research missions and align with national priority scientific agendas. Given this complementarity, creative collaboration between the CPR and the strategic research centers needs to be strengthened.

The large-scale research infrastructure centers, including BioResource Research Center (BRC), Center for Computational Science (R-CCS), and SPring-8/SACLA Center (RSC) play centrally important roles in supporting research activities within RIKEN and contributing to the global scientific community. Their activities form a crucial component of RIKEN's international brand.

The RIKEN Cluster for Science, Technology and Innovation Hub (RCSTI) is now at an early stage of development and needs a more concrete plan. Its present organization is highly complex and in need of simplification. That said, its overall vision appears sound and we look forward to its full implementation.

The fact that the frontiers and costs of science are rapidly expanding should be recognized in future budget allocations by the Japanese government. In any event, RIKEN must always focus its efforts in areas that are most likely to produce the largest dividends in terms of discovery and potential for innovation, and must continue to make difficult choices if it is to remain competitive at the leading edge of science.

RAC recognizes that a robust research integrity process is essential, and commends RIKEN for the measures it has taken in this regard. RIKEN should continue to strengthen its activities in this area, and we ask for an update at the 12th RAC meeting.

TOR 2.2 Human resource development

We commend RIKEN for appointing an Executive Director with specific oversight over career development and workforce diversity. This new leadership focus is an important step toward addressing long-term challenges RIKEN has continued to face in the recruitment and cultivation of human resources, its most important asset. The Executive Director has an excellent plan, which needs the continued full support of RIKEN.

The introduction of new programs designed to support scientists at all stages of their careers, from student trainees to postdoctoral fellows, to independent scientists is also laudable. The Hakubi Fellows program (which is currently funded from the President's discretionary budget) is especially promising. RAC strongly recommends that the number of Fellows be increased substantially, through provision of significant supplementary government funds to support an enlarged Hakubi program at RIKEN.

There is an evident decline in young talent entering science and innovation in Japan, something noted by leaders of multiple research and infrastructure centers during the present RAC meeting. This decline creates a set of risks that may affect the ability of RIKEN to achieve its long-term goals. RIKEN must develop proactive strategies for dealing with this national challenge and avoiding lose-lose scenarios in which the decline in numbers of PhD students and reduction in available early-career posts may reciprocally depress the entire research labor market. One means of raising the interest of younger people in pursuing a career in science would be for RIKEN to implement an internship program for high school and undergraduate students.

As RIKEN initiates more innovation-oriented activities, it will need to recruit and cultivate talented specialists who are familiar with technological demands in basic science, and who also possess the engineering skills needed to address them. There is continual demand for such individuals in industry, meaning talent development by RIKEN centers can contribute to national scientific competitiveness as well.

We provide more detailed suggestions regarding specific pressing issues relating to mentorship and diversity in the research labor force in Key Recommendation 6 and the Appendix, below.

TOR 3. SOCIALLY RESPONSIVE R&D, RESEARCH INFRASTRUCTURE

The individual Advisory Councils have rated each Center highly for performing excellent research in its respective domain in a manner that addresses relevant societal issues. The higher-level strategy of clustering the centers to address overarching challenges of a “Super Smart Society”, “Healthy Life Expectancy, and “Sustainable Society” remains in early development. More time and effort are required to interlink and incentivize the Centers to work cooperatively and take ownership of the challenges they confront.

The major research infrastructure facilities are world-class and to the credit of RIKEN and Japan. They are well managed and serve key roles in national, regional, and global collaboration. In general, we support the individual AC recommendations that

budgets should be adequate for the operational needs of each type of infrastructure, and for essential upgrades.

In particular, the RIKEN Nishina Center is preparing for a strategic upgrade, which would enhance its performance and enable it to maintain its world-leading role in the study of the origin of elements, as well as to explore potential applications in agriculture, medicine and other fields. There is a strong case for this upgrade and RAC supports this plan, as long as supplementary resources can be obtained without compromising other scientific activities.

The reorganization and mergers of life science centers to form BDR has been at the expense of the global visibility and reputation of the former CDB and QBiC, whose productivity and international impact were very high. With strategic direction, this consolidation may bring dividends, but critical decisions need to be made regarding the research focus and location of the new PIs to be recruited over the next 3–4 years. In the short term, increasing the international visibility of BDR is important.

We welcome measures to stimulate interdisciplinary research and new ideas through internal funding, but it should be recognized that entirely novel fields of research cannot be prescribed or achieved in a short time. Over the longer term, RIKEN is well positioned to achieve this goal given its broad scientific expertise, and the freedom afforded by strong administrative support and the general absence of teaching commitments.

All-RIKEN projects can be a valuable component in promoting collaboration within RIKEN, which is essential for addressing contemporary research questions. The principle of the Cluster for Pioneering Research to encourage bottom-up ideas is also welcome. Together with programs for promoting scientific excellence, this can promote new areas of research within RIKEN. Special consideration should also be given to increasing the number of Hakubi Fellows with additional support from government funds.

Active organizational measures are important to facilitating interactions given the geographical dispersion of RIKEN scientists. Simplification and clarification of internal communications will also contribute to this goal. The iTHEMS program represents a promising endeavor for enabling new forms of interdisciplinary research, blending mathematics and theoretical approaches to a spectrum of research questions. Its approach could benefit from comparison with successful examples of similar organizations, such as the Kavli Institute for Theoretical Physics at UCSB and the Perimeter Institute. We note that iTHEMS may need to expand its leadership beyond a single director in the interests of ensuring the long-term sustainability of the program.

Finally, the Fugaku supercomputer will be a powerful resource that should be used to support new research programs and applications. The core center should continue to explore ways to work more closely and effectively with the broader academic HPC community.

The RIKEN-wide data management policy is a positive development. All RIKEN PIs should be required to deposit data and RIKEN should promote unrestricted access, within appropriate limits mandated by consideration for personal and confidential data. As a matter of general policy, RIKEN should promote open science.

TOR 4. RIKEN INNOVATION CO. LTD, PARTNERING WITH INDUSTRY

Establishing the RIC marks an important paradigm shift for RIKEN. If successful, this could be the key foundation for cross-fertilization between RIKEN and corporations in the future and greatly support RIKEN's goal to make a positive impact on Japanese business, the economy and society as a whole. Moreover, we note that increased research output and profits from companies derived from RIKEN research, mediated by RIC, has the potential ultimately to contribute to public capital resources through, for example, increased tax revenues.

Launching an independent subsidiary is a bold new undertaking for RIKEN, and one that will require new sets of experience, skills, and perspectives. However, RAC recognizes the potential risks inherent in this type of initiative, particularly in governance, and measures should be put in place to mitigate the risks. Below, we outline some general and specific considerations for RIKEN during the launch and early days of this important new venture.

General recommendations for TOR 4

- RIC urgently needs a CEO and a comprehensive business plan.
- The new CEO should be hired from industry and have a business background, preferably in a science and technology field.
- The core function of RIC should be support for startups, which will add value to RIKEN patents through technology licensing, increase RIKEN's visibility, positively impact society through the creation of new jobs, and positively impact companies through the opportunity to acquire valuable startups.
- The overall structure of RIC should be simplified by reassigning the function of "membership-based co-creation," which is currently a separate focus, to a subset of the activities under "collaborative research promotion." Consulting should also be included within this expanded organizational focus, which we suggest could be renamed "Collaborative Research Promotion and Consulting." Reducing the core functions from the current four to three will streamline and rationalize RIC's mission.

Specific recommendations for TOR 4

We recommend a number of specific changes to the organizational structure and planned activities of RIC, relating to licensing, support for startups, promotion of collaborative research, and membership-based co-creation.

1. Technology licensing
 - Develop a patent strategy to decide between (i) sale, (ii) licensing, and (iii) usage to support a startup company.
 - Technology Licensing must be aligned with support for startups and collaborative research promotion. Intellectual property can be used in several different ways: for collaborative partnerships within RIKEN research labs, or as the basis of start-up companies, or for sale or licensing.
 - Consideration should be given to opportunities to license IP in areas other than biosciences, for example from the Center for Computational Science.
2. Startup support
 - RIC should develop strategies for maximizing the value and chances of success of its startups.
 - Policies must be established on the acquisition of startups by Japanese and foreign companies.
3. Collaborative research promotion
 - This focus should be expanded to include consulting functions, and renamed “Collaborative Research Promotion and Consulting.”
 - All functions of RIC require administrative and legal oversight.
 - There is a need to review RIKEN’s existing relationships with industry partners to ensure RIC business activities do not jeopardize current relationships.
 - RIKEN should encourage interaction with industry by allowing PIs to consult for industry for up to 20% of time, consistent with international practices.
4. Membership-based co-creation
 - “Membership-based co-creation” should be reassigned to fall under the new general heading “Collaborative Research Promotion and Consulting.”
 - Membership fees for consortia may raise potential conflicts of interest if they include companies that concurrently sell products to RIKEN. For example, a microscope company that sells to a strategic research center may have competing interests as a vendor and consortium member.

KEY RECOMMENDATIONS

1. Human resource development and diversity

RIKEN faces a number of ongoing challenges in recruiting, training and retaining scientific and administrative talent. Adjustment of the proportion of fixed-term and indefinite-term staff in response to the amended labor law requires careful thought and gradual implementation. RIKEN also needs to devise new strategies for attracting the best scientific potential at a time when enrolment in graduate school programs in the sciences is in decline across Japan.

As noted by multiple previous RACs since 2004, foreign and female scientists are massively under-represented at RIKEN (see Appendix). While some initiatives have

been undertaken to bolster employment in these categories, they have yet to show the expected results. With specific regard to increasing employment of women scientists, we have included an Appendix of further recommendations to supplement those made by RACs in the past. We recognize the systemic challenges within Japan, but feel nonetheless that redoubling its efforts in this endeavor would benefit RIKEN in the long run, and would additionally align with President Matsumoto's vision of RIKEN as a driver of positive social change.

Stronger career development support for young researchers is also a key area in which RIKEN should invest. The Hakubi and Kato Sechi Fellows programs are a good start for attracting elite-level young scientists. But additional attention should be paid to implementation of support such as mentoring and career development programs for researchers at every stage in their careers, including student trainees and postdocs.

2. Scanning the scientific horizon without losing the way

RIKEN is continuously redefining itself in response to changing scientific trends and the demands of society. At the same time, it must not lose focus on its core mission and its identity as a premier basic research institute. The pursuit of new initiatives should not come at the expense of RIKEN's unique and historic strengths. But it is equally important for RIKEN to stay up to date with the latest trends and developments in the fields in which it seeks to compete on the international stage. Mechanisms should be in place centrally and at individual research centers to monitor and keep in front of key scientific and technological developments, and conduct hiring and resource allocation accordingly.

No organization can lead in every field, and prioritization is essential, but we urge RIKEN to ensure it is not missing out at an institutional level when new concepts and techniques come over the horizon, which can be facilitated by international collaborations and recruitment.

3. Promoting and managing interdisciplinary research and collaboration

RIKEN's increased focus on interdisciplinary research is laudable. The future of science, and especially the creation of new research fields, is found in the spaces between disciplines. Whether collaborations take place entirely within RIKEN, or with external partners, effective communications within and between disciplines is essential. We note that some fields of historical strength within RIKEN (such as chemistry) may require support in facilitating communications, especially in light of the dispersal of labs across multiple campuses. Such support could take the form of a senior PI serving as a visible champion for the fields and facilitator of information exchange among labs.

Although RIKEN is extremely diverse in its research, there are always gaps that can be filled only by partnering with other academic or industry organizations, in Japan or

abroad. Closer collaboration with national research institutes has especially great potential both to build the scale needed to make Japan internationally competitive in important fields, and to respond to government demands for consolidation of research effort and breaking down of institutional silos.

RIKEN would also do well to identify additional local partners in regions of Japan where RIKEN has a presence, such as a research campus. Such partnerships allow both organizations to take advantage of proximity effects.

RIKEN has entered into many MOUs with research institutes overseas, but most appear to be only paper agreements. It may be time to focus on a smaller number of institutes, which provide opportunities for substantial and synergistic joint research.

4. Better performance indicators

Evaluations of institutional and individual productivity are dependent on the use of valid quantitative metrics, both for internal use and in responding to demands from policymaking and funding agencies. RIKEN must pursue continuous improvement in the means by which it assesses its own outputs, and draws comparisons with other institutions. Across the organization, well-defined metrics and key performance indicators (KPIs) should be introduced to enable fair and accurate performance reviews. Comparisons across fields and institutions must be normalized to account for differences in funding and headcount.

In measuring its research output, RIKEN should explore more sophisticated bibliometrics approaches. The use of impact factors and average citation rates is no longer an accepted international standard. Investments should be made into obtaining the needed expertise in the latest performance review techniques. It may at the same time be necessary to communicate with government agencies to persuade them to update their own standards. Importantly, RIKEN should investigate best practices in combining qualitative and quantitative metrics. The best measures of the success of a research project are its impacts within the field and on society. However, such impact may be difficult to capture using traditional indicators, especially in the years immediately following a truly novel discovery or innovation. RIKEN should take advantage of the deep body of expert knowledge represented by the Advisory Councils for individual research centers to obtain input on their most important achievements.

Monitoring the impact of RIKEN employment and training practices should also rely on innovative metrics. More effort should be expended on tracking the career decisions and pathways of RIKEN alumni. Implementing exit interviews for departing staff, for example, may provide insights into RIKEN's strengths and weaknesses as an employer, and inform new human resource development strategies.

5. Managing and sharing data

Collection, storage and analysis of enormous sets of data are increasingly important, indeed unavoidable, in all fields of science. RIKEN itself already possesses a huge amount of data and research information in various fields. To support collaborative sharing among partners across remote locations both inside and outside of the institute, and to fulfill its responsibilities for the preservation and curation of research results, RIKEN must implement repositories for both its research achievements (publications) and the underlying data. Of course, appropriate safeguards must be in place for protecting personal data and confidential/proprietary information. Introduction of a repository system is consistent with and potentially fortunately timed given the current excellent plans to reform RIKEN's information and communication technologies (ICT) systems.

Such institutional repositories and data management systems are now the standard at leading research organizations, and responsible data storage and sharing should be considered a mandatory part of a RIKEN scientist's terms of employment. Repositories are only useful to the extent that they are well maintained, which may require the introduction of incentive schemes, such as including only registered publications in individual and institutional performance reviews.

RIKEN should also explore instituting a policy on Open Access Publishing (OAP), and seek supplementary government funding to support payment of author processing charges (APCs) by RIKEN labs. OAP represents the most efficient means of sharing research results throughout the scientific community and moreover has been shown to increase citations and impact of publications.

6. Strategies for success in translational research

Consistent with its institutional goal of expanding its research to address the needs of the Japanese economy and society at large, RIKEN has made important strides in the translation of basic research results into potential new therapeutic applications. Such work requires collaborative efforts among RIKEN's many excellent strategic research centers and infrastructure facilities across the life sciences. But it also demands the integration of capabilities from other disciplines, such as machine learning and data science.

Clinically directed R&D, in particular, involves an array of complementary approaches and techniques, from genetics, structural biology, molecular and cellular biology to predictive chemistry and high-resolution imaging. This modern approach to clinical R&D presents excellent opportunities for RIKEN to leverage its broad and deep portfolio of research programs. In particular, the demand for effective strategies for the collection and analysis of extremely large datasets is a fact of translational research in the modern era. Working with partners in academia and industry, RIKEN should establish competencies in management and sharing of data from fields such as human genomics and epidemiology. Partnerships with academic hospitals should provide essential access to clinical data, samples, and medical expertise.

7. Strategy for RIKEN Innovation Co. Ltd.

RIKEN should fully develop and support the RIC while paying close attention to the governance structure, and implement the changes recommended in TOR 4, above.

Appendix: Redressing gender imbalance

RIKEN continues to have an unacceptably low percentage of female scientists, especially at senior levels. This situation has been identified as a problem area by RACs since the early 2000s. Despite that repeated emphasis, percentages of female directors, PIs, and research scientists have not increased satisfactorily. The 11th RAC reaffirms that increasing female representation is critically important, especially in light of the goal of driving societal change, as emphasized by the Cabinet Office and President Matsumoto.

Given RIKEN's status as a global institution, it should take the lead in implementing measures (including adoption of successful models from other countries) to increase its employment of female scientists. High priority should be given to recruitment of female scientists at the Director, Chief Scientist, and PI levels. The current recommendations reiterate several of the recommendations made by previous RACs. We encourage RIKEN to review detailed recommendations on this issue made by RACs in 2009, 2011, 2014, and 2016 as well.

1. "Gender equality training" should be compulsory for all RIKEN staff. The goal of this program should include training for relevant staff on how to run search committees in a way that is not biased against female applicants. Many studies have found that bias against women is unconscious but entrenched, and that even women may tend to be biased against women. Training should be aimed at overcoming such prejudice. We note that gender equality training is required at many universities in US, UK and elsewhere. Training could take the form of a mandatory, comprehensive online course. Examples of international gender equality programs can be found at <http://www.equality.admin.cam.ac.uk> (Cambridge University) and <https://faculty.yale.edu/faculty-search-committee-resources> (Yale University).

2. Good hiring practices should include:

- Top-level positions (Director, Chief Scientist) should be advertised in a way that encourages female candidates to apply. Advertisements should also ask for both nominations and self-nominations.
- A database of outstanding female scientists should be assembled to help in recruiting women to top-level positions (especially Japanese women who are currently working overseas).
- All search committees must have female members, which may need to include members from outside RIKEN.
- For PI-level or higher appointments, at least one female scientist should be included on the shortlist of candidates, and at least one female scientist should be among the recommendation letter writers.
- Search committees should have a member whose role is to confirm that the procedures are fair for women and minorities.

- Additional financial resources should be made available to recruit top women into senior positions.

3. “Sexual harassment training”

- For all members of staff mandatory instruction needs to be provided on unacceptable sexual behaviors, and how to handle situations where sexual harassment has been reported or suspected.

4. Family-friendly working conditions

Because family-unfriendly working conditions may discourage women from pursuing research careers, the working group recommends:

- Day care should be available onsite. We commend RIKEN for establishing daycare services at or near many of its campuses.
- All essential meetings and seminars should be held during regular working hours, so that individuals with caring responsibilities can attend.
- Explore support grants for staff with young children.

5. Facilitate the organization of a RIKEN network for female scientists to discuss challenges women face and formulate proposals for the advancement of women in RIKEN.

- Liaison between the female scientists’ network with the office of gender diversity within the administration.