Document 3-2

National R&D Agency, Institute of Physical and Chemical Research (RIKEN) Mid to Long-term Objectives Comparative Table (draft)

Next mid to long-term objectives (draft)	Current mid to long-term objectives	Remarks (reason)
(Preface) In accordance with the provisions in Article 35-4, paragraph (1) of the Act on General Rules for Incorporated Administrative Agencies (Act No. 103 of 1999) and Article 5 of the Act on Special Measures Concerning the Promotion of Research and Development by Designated National Research and Development Agencies (Act No. 43 of 2016, “the Act on Special Measures”), objectives concerning the administration of the operations to be achieved (“mid to long-term objectives”) by National Research and Development Agency Institute of Physical and Chemical Research (RIKEN), will be set.	(Preface) In accordance with the provisions in Article 35-4, paragraph (1) of the Act on General Rules for Incorporated Administrative Agencies (Act No.103 of 1999) and Article 5 of the Act on Special Measures concerning the Promotion of Research and Development by Designated National Research and Development Agencies (Act No.43 of 2016) (hereinafter referred to as “the Act on Special Measures”), objectives concerning the administration of operations (hereinafter referred to as “mid to long-term objectives”) to be achieved by the Institute of Physical and Chemical Research, National Research and Development Agency (hereinafter referred to as “RIKEN”) are set.	

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1. Position and role of RIKEN in the policy system National R&D Agency, Institute of Physical and Chemical Research ("RIKEN") has a history of over a hundred years of operation since its foundation as an incorporated foundation, and now has grown to the largest and highest-level comprehensive research institute for general natural science in Japan. Based on the long history, RIKEN, promoted as a designated national R&D agency according to the Act on Special Measures, is expected to produce the world's best R&D outcomes to meet national and social needs with all its strength and serve as a core agency to vigorously drive innovation systems in Japan in this new millennium. For this purpose, RIKEN is required to make a great leap forward as a designated national R&D agency aiming to create innovation in Japan, namely, new intellectual and cultural values, and connect them to the creation of social, public and economic values in active collaboration with research institutes and other organizations more ambitiously than ever through proactive efforts to achieve outstanding R&D outcomes in various fields of science based on national and social requirements such as the Science and Technology Basic Plan, maintain and share the world's best research infrastructure, and provide an excellent research environment and advanced research systems serving as the model for other research institutes in this mid to long-term objective period. RIKEN would be regarded as one of the most esteemed research institutes in the world that decide global trends of research and development by pioneering totally new research areas and creating research seeds which would innovate the whole world. To play such a role, it is important to establish a research management system targeting innovation under the leadership of the president. RIKEN needs to set out a vision for achieving its task, and develop relevant rules and systems. Efforts to make under this research management system include the implementation of strategic R&D, establishment, operation and upgrading of the world's best research infrastructure, creation of new	I. Positioning and Roles of RIKEN in the Policy Framework RIKEN is one of the largest and highest-level comprehensive research institutes for general natural science in Japan. It is expected that RIKEN strives to solve important issues faced by Japan and international communities by use of its advantages to the fullest extent possible as a national research and development agency designed to contribute to sound development of national economy through improving the scientific and technological levels of Japan and to work hard toward the realization of innovation and the creation of new values through exploiting its collective strengths. Also, the Act on Special Measures positions RIKEN as "designated national research and development agency." Therefore, it is required for RIKEN to produce the world's highest level of research and development outcomes which set the basis for scientific and technological innovation and serve as a core organization which strongly drives the Japanese innovation systems. In addition, RIKEN shall respond to a request in case where any innovative knowledge concerning science and technology is found and necessary measures shall be taken in order to swiftly deal with such knowledge. To this end, it is required for RIKEN to endeavor to develop outstanding research environments and advanced research systems at all times as a world-class research and development agency, strengthen its research and development capabilities under the leadership of the President to explore new research fields, and strengthen its management function. It is also necessary that RIKEN demonstrates its collective strengths as a comprehensive research institute for general natural science toward the solution of issues to be addressed by the government listed in the Science and Technology Basic Plan and engages in research and development activities to fulfill the following missions 1. Promoting strategic and focused research and development based on	

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sciences for supporting innovation in the future, social return of research outcomes in organization to organization collaboration with external agencies, development of an excellent research environment, and recruitment and development of outstanding human resources. In doing so, it is essential to propagate the management policies of RIKEN in related organizations and staff members, and develop the environment where individual researches can concentrate on their own R&D activities with originality and ingenuity while sharing the vision. In regard to research misconduct, misuse of research expenses, maintenance of ethics, and adherence to legal requirements, RIKEN is also required to act appropriately as the model for outside researchers and R&D institutes. (Appendix 1) Policy Chart concerning RIKEN	national and social needs; 2. Promoting development and shared use of the world's highest level of research infrastructures; 3. Promoting creative and challenging advanced integrative researches that could bring about a paradigm shift; 4. Effectively using research and development outcomes for the benefit of society through collaborations inside and outside RIKEN and the establishment of networks in view of their application to industry and medical fields; and 5. Developing research environments and nurturing and producing talented researchers. It is of paramount importance for everyone who engages in science and technology to review not only the benefits brought about by science and technology but also risks thereof, the social responsibilities of research institutes and individual scientist, and the involvement of society in science and technology. RIKEN has produced research and development outcomes that take the lead in natural science of Japan. It must continue to progress in response to the changes of the times and the needs of society. It is extremely important for RIKEN to serve as a model of other research and development agencies and researchers in the world of natural science and to proactively engage in daily research and development activities as the entire organization and individual researchers in regular contact with cultural science and social science. It shall be aware that science and technology evolve into the creation of new world views and values taking into account the roles which people expect natural science and RIKEN to play. RIKEN is expected to be a model of other researchers and research and development agencies also in terms of prevention of research misconduct or misuse of research expenses, and maintenance of ethics and compliance.	

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	It is our sincere desire that RIKEN continues to grow as a research institute in society which is highly appreciated in the world and to be always expected and respected by people through the above activities so that it brings about breakthroughs in improvement of the scientific and technological levels, science and technology get closer to people and RIKEN contributes to the creation of richer culture. Based on the above, the mid to long-term objectives of RIKEN shall be formulated. (Appendix 1) Policy chart concerning RIKEN	

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2. Period for mid to long-term objectives The period of this mid to long-term objectives is seven years from April 1, 2018 to March 31, 2025.	II. Period for Mid to Long-term Objectives The third period for the mid to long-term objectives shall be the five years from April 1, 2013 to March 31, 2018.	
3. Maximization of R&D achievements and quality improvement of the other operations Specific objectives are covered in this section according to the position and role of RIKEN in the policy system described in Section 1. In addition to those described below, efforts will be added later in a flexible manner due to an increasing need for responding in view of various situations. In particular, when innovative insight on science and technology is found, or internal or external situations of science and technology significantly change, and the Minister of Education, Culture, Sports, Science and Technology asks for relevant R&D or other operations, RIKEN will immediately respond to that request pursuant to the Act on Special Measures. The evaluation criteria and related indicators and indexes in Appendix 2 will be used for evaluating projects. (Appendix 2) Evaluation criteria	III. Matters on maximizing R&D achievements and others related to improvement of the quality operations RIKEN shall, as one of the core agencies that assume in the research and development functions which the government should be equipped with in the science, technology and innovation policies of Japan, engage in research and development in an organized manner toward the realization of innovation under the clear mission of solving national policy issues. As a result, outstanding research and development outcomes which have an impact on society are produced and they are used for the benefit of society. Moreover, RIKEN takes the role of core organization which creates the world's highest level of research and development outcomes and strongly drives innovation systems as a designated national research and development agency. For the solution of issues to be addressed by the government listed in the Science and Technology Basic Plan, RIKEN shall demonstrate its collective strengths as a comprehensive research institute for general natural science and engages in focused research and development focusing on the solution of issues in active response to national and social needs such as environment, energy, medical care and drug discovery by means of the exploitation of research potentials which RIKEN has cultivated through putting a broad range of research and development in practice to the fullest extent. In addition, RIKEN shall introduce a system to effectively conduct advanced basic researches with the aim of integrating different fields and exploring areas which result in creative outcomes (seeds) that support the above research and development, and shall steadily promote those basic researches. Since RIKEN is a research and development agency which fulfills	

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	the missions entrusted by the nation and society, it is of importance to present easy-to-understand goals and plans to citizens and society. It is also important that researchers, engineers and administrative staff have high social awareness and strive to achieve such goals through conducting research and development unitedly. Moreover, RIKEN needs to reinforce its management functions with the aim of taking advantage of the characteristics of research and development. Additionally, it is vital to create an environment in which no research misconduct is committed by strengthening governance of the entire agency and taking effective preventive measures for research misconduct taking its effect on society into consideration. When any evaluation is made, MEXT shall do so based on the separately-attached evaluation axis. (Appendix 2) Evaluation criteria	

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3.1 Establishment and operation of the research institute management system to maximize R&D outcomes and create innovation The efforts described below will be made to develop and operate an organization required for establishing and strengthening a research institute management system serving as the model for other research institutes under the leadership of the president as a designated national R&D agency for maximizing R&D outcomes and reinforcing the capability of RIKEN as a core agency to create innovation. (1) Reinforcing the system and function to support management under the president's leadership The organization and function of RIKEN will be strengthened and operated for supporting the operational decision of the president to accomplish self-governing corporate operation for creating innovation under the leadership of the president. Specifically, the function to plan, implement and promote practical R&D projects will be improved by analyzing national strategies and the picture of what society is supposed to be in the future, and consolidating a vision indicating the direction of RIKEN to head for in consideration of research and management resources owned by RIKEN. Efforts towards the identification and resolution of issues on R&D and corporate operation will be promoted from various perspectives within and outside RIKEN, such as recommendations and evaluations by external experts including renowned researchers overseas for R&D activities and corporate operation, and advice from core researchers in RIKEN for the direction of R&D and strategies aiming at developing new research fields. The organization should be improved so that optimum operations will be achieved under the leadership of the president and function to support the president for flexible budgetary steps and optimum budget allocation in the discretion of the president. This includes a horizontal and flexible research system and network structure to promote the creation of		

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innovation. (2) Improving the research environment and developing outstanding researchers to produce the world's best research outcomes Various outstanding researchers, including young, female and foreign researchers, will be employed in a positive manner to develop an energetic research environment and urge RIKEN to evolve into a world-leading R&D agency. In particular, the personnel system will be reformed to include long-term and permanent research contracts so that young researchers can concentrate on their research from the mid to long-term perspective. In this respect, sufficient consideration will be given to the balance between the mobility and stability of human resources in that the function to accept and foster researchers having diversified ideas and insights is important for the vitalization of RIKEN and the growth of the scientific society as a whole. At the same time, the permanent research staff will be encouraged to participate not only in projects for advancing research of their own, but those which are intended for the development of RIKEN for contributing to a broader range of research. The function and system of clerical and engineering work will be established to support R&D activities, including the assignment of research assistants, such as research clerical personnel and research assistants, and coordinators to promote liaison between RIKEN and outside institutions, and establishment of a suitable clerical work processing system to maximize research outcomes and promote social return of these outcomes while allowing researchers to proceed with their R&D activities effectively and efficiently. Acceptance and fostering of outstanding human resources in and out of Japan, organizational liaison with universities, proactive acceptance of students from universities in light of research collaboration with universities and development of outstanding human resources, liaison		

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with overseas research institutes, including joint research projects and personnel interchange, and formation and operation of overseas research centers will be strategically promoted to enable RIKEN to function as a hub of international brain circulation open to the world for improving the scientific and technological levels of Japan and promoting the development of young researchers in Japan. Systematic promotion of diversity will be taken into account to establish an environment in which female and foreign researchers can engage in their research in and efficient manner. In addition, it is important to gain a broad understanding and support of the public for the objectives and value of RIKEN by publishing the activities of RIKEN not only in the scientific society but widely in the public as a research institute representing Japan. In this respect, continuous efforts will be made for presenting and introducing research outcomes in the form of papers, in symposiums and public relations magazines in an easily understandable manner. Information on potential social return of research outcomes will also be distributed in an attempt to gain understanding and support from a broad range of people in Japan and abroad. (3) Promoting social return of research outcomes through close collaboration with related organizations Social return of innovative research seeds owned by RIKEN will be accelerated for creating innovation. For this purpose, open innovation will be promoted to provide a place for strengthening liaison with external organizations including the industry and universities and promoting collaboration beyond disciplines and categories to put research outcomes of RIKEN to practical use, and co-create new values by related organizations. Accordingly, efforts for improving the planning and implementing function and building a suitable organization will be strategically promoted as well as strategic acquisition, management and		

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use of intellectual properties. An attempt to acquire and use external funds will be made throughout these efforts. In particular, open innovation will be promoted to improve liaison with external organization not only through joint research by individual researchers but also in collaboration between RIKEN and other organizations to consolidate the knowledge and technologies inside and outside RIKEN. Social return of research seeds of RIKEN will be promoted as well as the acquisition and use of external funds to reinforce liaison with the industry by increasing organized, large joint research projects. In light of promoting and taking the lead for the creation of innovation, organizational efforts will be accelerated to manage and use intellectual properties of RIKEN, and nurture and support RIKEN-originated ventures. In collaboration with universities, a hub function for interconnecting organizations and keeping up the mobility of researchers in different fields will be established mainly by RIKEN to provide a place for expanding integrative research projects beyond the walls of organization and disciplines and sharing tasks in their respective realms of expertise. This may result in the creation of seeds for new, innovative fields of research by RIKEN and collaborating universities, and strengthening of collaboration with local governments and industries with the hub function as the core, accelerating social return of outcomes. In the health and medical sectors, efforts for creating innovative drug discovery or medical technologies will be promoted in collaboration with the government. This includes the support for commercializing innovative seeds inside and outside Japan using the research infrastructure of RIKEN in a cross-sectoral manner as a contribution to promoting commercialization of a national (ALL-JAPAN) project research outcomes. (4) Exploiting and creating new science to support sustainable innovation		

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in Japan It is important to exploit and create new fields of research and produce highly impact, new and innovative research seeds for achieving science, technology and innovation. In this respect, new fields of research will be exploited or created through R&D based on a wealth of knowledge and imagination by researchers having outstanding research performance, in-depth insights and ability for leadership irrespective of research fields, and cross-sectoral, integrative research projects in RIKEN. To promote these efforts, researchers will undertake research beyond their specialty, target setting and progress management of R&D will be strictly associated with scientific and social significance of relevant research themes, and constant improvement will be made according to situations, including priority given to the themes of increasing importance or necessity in a flexible manner, or review of the themes of decreasing importance or priority with disposal in mind.		

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3.2 Promotion of strategic R&D based on national strategies, etc. RIKEN will deal with national and social demands included in national strategies such as the Science and Technology Basic Plan as a core research institute for science, technology and innovation in Japan, and undertake strategic R&D in the fields listed below for creating and maximizing outstanding R&D outcomes. To accomplish objectives defined in each R&D field, RIKEN will set up major R&D themes by field each ranging from the creation of new insights to final propagation of research outcomes into society based on national strategies, and provide the procedure and outcomes expected to be obtained according to the progress of R&D in the mid to long-term and annual plans. According to these plans, progress management and evaluation of R&D projects, and necessary improvement and review will be carried out every fiscal year in the integrated operation system in RIKEN described in 3.1 for promoting cross-sectoral collaboration within RIKEN and individual R&D management according to the relevant fields to maximize R&D outcomes. (1) Advanced intelligence projects While application of IoT and AI technologies is on the increase with the development of ICT, Japan must be first to realize a “super smart society” in the world, and produce added values from big data. Efforts to achieve this include theory construction for clarifying the principle of deep learning, and R&D of core technologies applicable to highly complicated and incomplete data the current AI technologies cannot solve, and using these core technologies in part, scientific research of the fields Japan has advantages, such as regenerative medicine, will be further reinforced to produce research outcomes for resolving social issues in Japan, such as disaster management. The ethical, legal and social issues in using AI technologies will also be studied, the results published. These efforts will	1. Promoting strategic and focused research and development based on national and social needs RIKEN shall establish its organization and systems in a way that research and development are performed more effectively through utilizing research and development capabilities and functions cultivated in the past as a core organization that implements the policies for scientific and technological innovation of Japan, and contribute to the fulfillment of policy issues through demonstrating its collective strengths as a research institute for general natural science toward the solution of issues to be addressed by the government listed in the Science and Technology Basic Plan. In addition, RIKEN is required to promote strategic and focused research and development which link basic researches to applied researches based on diverse social needs. Moreover, individual research and development projects whose necessity has decreased, because their objectives have been achieved, or whose priority has decreased in the light of scientific impacts and social needs, shall be strictly reviewed as needed including their discontinuance. Also, RIKEN shall swiftly respond to projects whose need has increased in view of different circumstances. The details are described in Appendix 1. It should be noted that, based on the Action Plan for Renewal of Higher Morals including Prevention of Research Misconduct formulated in August 2014, it is important to carry out necessary reviews concerning the RIKEN’s operation and research systems.	

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enhance advanced R&D and human resource development, and steadily proceeded in close collaboration with related ministries, government agencies, institutions and private enterprises and in consideration of global trends. (2) Theoretical and mathematical sciences Importance of interdisciplinary research in natural and social sciences is increasing and methods based on theoretical and mathematical sciences are sought after for sharing and integrating scientific methods developed separately in various fields, extracting information from large data, and controlling highly complicated systems. Theoretical and computational sciences in physics, chemistry and biology, etc. will be integrated with mathematics and mathematical sciences as the core to find mathematical science based fundamental questions in natural science (e.g. origin of universe and life) and a number of issues to meet national and social needs (e.g. progress of mathematical modeling technologies for natural and social phenomena). Looking at these fields and layers in a cross-sectoral manner, social issues that can be clarified will be identified and human resources to promote the work will be developed. (3) Medical sciences Various therapeutic methods including innovative immunotherapy have been developed for treating cancer and adult lifestyle-related diseases, but issues such as individual variability for drug efficacy and side effects hinder the propagation of these treatments. Selection of optimum treatments for individual patients by stratification of diseases at genetic level and comprehensive clarification of pathogenic mechanism is required. Accordingly, outcomes obtained from fundamental R&D for clarifying the basic principles of human immune system, development of core technologies of humanized mice, etc., comprehensive identification of disease-related genes, and functional genomic analysis and research		

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using single-cell technology will be developed and integrated for promoting research to achieve individualized and preventive medicine in cancer immunotherapy. (4) Bio-functional science In a super aging society like Japan, prolonged healthspan is in high demand, and it is imperative to keep people healthy and clarify aging mechanisms. Efforts to find solutions to these issues include the development of non-invasive visualization techniques and prediction and search methodologies for establishing cellular state diagnosis and evaluation procedures, clarification of 3D mechanisms of organ formation and control principles for establishing next-generation regenerative medicine, and development of non-/low-invasive techniques for measuring health/normal state. Using these techniques, mechanisms of maintaining biological functions at various levels from molecular to individual study throughout generation, growth, development and aging will be clarified to promote research for overcoming age-related dysfunction. (5) Brain and neuroscience In a super aging society like Japan, clarification of high-order function of human brains is in high demand for analyzing the pathogenic mechanisms of mental and nerve diseases, developing diagnostic and treatment methods, and upgrading AI. Accordingly, research for understanding the structure and function of human brain will be promoted based on the insights obtained so far. This includes research of imaging for high-order cognitive functions of human brain, cross-cutting brain research at all levels from genic to phenotypic levels, research of calculation principle relating to high-order cognitive functions, research of data driven brain, and R&D of diagnostic and treatment methods for mental and nerve diseases.		

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(6) Sustainable resource science To solve global issues such as resource depletion, climate change and food insecurity, development of innovative technologies for efficient production of food, biomass, pharmaceuticals, and chemical industry materials with less environmental load is in high demand. Accordingly, improvement of plant character, synthesis of useful materials of plants and microorganisms, development of high-order functional recycling catalysts using earth resources, and development of high polymer materials having useful functions will be promoted by integrating plant science, microbiology and chemistry, adopting data science using genome information and environmental data. (7) Emergent matter science R&D of environment and energy saving related technologies, such as ultralow power consumption devices, is in high demand to realize an environment-conscious, sustainable society. Accordingly, previous and current R&D will be integrated and accelerated to tackle four research themes, namely, energy functional emergent matter, emergent functional soft materials, quantum information electronic technologies and topological spin electronics, and the development of new materials for collecting heat and light in the environment highly efficiently and converting them to energy, and the establishment of a new doctrinal structure and development of proof of concept devices to implement innovative hardware with ultrahigh speed and ultrahigh efficiency information processing technologies and ultralow power consumption energy technologies. (8) Advanced photonics Optical and quantum technologies are core technologies Japan has advantages for realizing a “ultra-smart society,” and need to improve		

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innovative measuring, information and energy transfer and processing technologies. Accordingly, R&D of new optical and quantum beam technologies will be promoted with the most advanced optical and quantum generation, control and measuring such as extremely-short optical pulse generation and measuring technologies, ultra-precision laser control technologies, and nondestructive testing techniques using insights obtained so far to solve important social issues including the development of innovative materials and maintenance of infrastructure structures in addition to the most advanced academic studies such as the clarification of ultrahigh speed physical phenomena and super-resolution imaging of living organisms. (9) Accelerator science Fundamental understanding of matters and solving a mystery of matter creation, and by applying the outcomes, solutions for issues concerning food, health, environment, energy and resource are in high demand. Accordingly, enhancement of accelerators at the RI beam factory, which constitutes a research infrastructure, will be promoted, and basic research of atomic nuclei including nucleosynthesis processes will be extensively proceeded in addition to the active commercial application of heavy ion beams in agriculture, industry and RI pharmaceuticals. Establishment of nucleosynthesis technologies will be promoted for achieving an “island of stable nucleus,” in which the life of nucleus is expected to be significantly prolonged, by challenging the synthesis of new elements beyond atomic number 119.		

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3.3 Establishment, operation and upgrading of the world's most advanced research infrastructure As the world's best research and development agency, RIKEN will steadily improve and share the most advanced research infrastructure including ultrahigh speed computer, bio-resource infrastructure, and large-scale synchrotron radiation facility, as described below, and create and maximize outstanding R&D outcomes inside and outside the agency by promoting studies on enhancement and application. To accomplish the objectives set forth for individual fields of research infrastructure, RIKEN will identify specific issues concerning the operation, enhancement and application of research infrastructure by research field, and predict potential outcomes in the mid to long-term and fiscal year plans according to the way of proceeding and progress of projects, while noting the creation of R&D outcomes inside and outside the agency. Based on these, annual progress management and evaluation for individual fields of R&D infrastructure, accompanied improvement and review, and utilization of cross-sectoral collaboration will be promoted under the operation system for the entire agency, described in 3.1, as well as individual R&D management according to the associated fields to maximize the research outcomes. (1) Computational science Shared use of supercomputer "K" will be steadily continued pursuant to the Act on the Promotion of Public Utilization of the Specific Advanced Large Research Facilities (Act No. 78 of 1994, "Public Utilization Act") and according to the extremely stable operational results. Post "K" will be developed to start operation early, and computational resources will be provided for researchers as common resources after a smooth transfer from "K" to post "K." In addition, insights of computational science and computer science obtained from "K" and post "K" will be developed for creating outcomes and propagated for solving social and scientific issues.	2. Promoting development and shared use of the world's highest level of research infrastructures and promoting researches using such infrastructures As the world's highest level research and development agency, RIKEN shall steadily improve and operate the research infrastructures necessary for cutting-edge research and development such as the heavy-ion accelerator facility, large synchrotron radiation facility, BioResource infrastructure, life-science technology infrastructure and ultrahigh-speed computer. Moreover, RIKEN actively addresses creative and challenging research and development agendas by use of such facilities so as to produce specific outcomes conducive to breakthroughs in science and technology and socioeconomic development, and improves an environment in which those facilities are widely shared by Japanese and overseas researchers. When an environment of use is improved, it is of the highest importance that these research infrastructures are employed for various types of research and development in broad scientific and technological fields so that the advantages of such research infrastructures are demonstrated and more useful outcomes that contribute to breakthroughs in science and technology and to socioeconomic development are produced. Under this recognition, RIKEN also upgrades its facilities and technologies which use them based on trends of research and development and users' needs and considers a possibility of introducing the appropriate beneficiaries-pay principle of usage fees for the benefit of users. Furthermore, RIKEN shall actively push forward the establishment of utilization environments toward the creation of originative research and development outcomes and innovation through organic collaborations of these cutting-edge research infrastructures.	

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(2) Synchrotron radiation science Stable operation of large-scale synchrotron radiation facility (SPring-8) and X-ray free electron laser (SACLA), both of which have been widely used for academic research and industrial application, will be promoted for continuing shared use pursuant to the Shared Use Act, and not only academic research but also industrial use will also be promoted through enhancement of application technologies including high-speed and large-capacity data processing, expansion of user support systems, and improvement of facility performance etc. Core technologies for structural analysis complementary to SPring-8 and SACLA using insights obtained so far. (3) Bio-resource research The world's best bio-resources will be strategically developed in terms of utility value, additional information and quality, and offered according to social and research needs for research ranging from basic and fundamental research to development and research for solving social issues. Core technologies for preservation and application will also be developed for providing effective and efficient bio-resources. R&D for using streamlined bio-resources will be promoted by accurately understanding research trends. In addition, development of human resources who will get engaged in bio-resource projects, and technical training and dissemination for transferring technologies to research communities will also be promoted.	In addition, based on the Act on the Promotion of Public Utilization of the Specific Advanced Large Research Facilities (Act No.78 of 1994), RIKEN shall contribute to promotion of science and technology by conducting the business provided for in Article 5 of the said Act (excluding usage promotion services by registered institution for facilities use promotion). RIKEN shall also strive to determine the users' needs for its cutting-edge research facilities and large facilities which are not provided for public utilization currently and aim to expand public utilization as much as possible in consideration of its benefits. The details of the measures for promotion of development and shared use of individual research infrastructures and of researches conducted by use thereof are described in Appendix 2.	
	3. Promoting creative and challenging advanced integrative researches that could bring about a paradigm shift RIKEN is, different from universities or other agencies, capable of establishing its research and development system flexibly and swiftly with an emphasis on the viewpoint of research and development whose	

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	objectives are more clarified. Moreover, RIKEN is able to conduct research and development without any restriction on specific research field as a comprehensive research and development agency for science and technology unlike other national research and development agencies. It is important for RIKEN to strengthen the capabilities of exploring research areas and fostering next-generation R&D fields with the help of those characteristics. From this point of view, RIKEN shall develop the functions and techniques of advanced integrative researches cultivated thereby in the past by use of its collective strengths, and, under the leadership of the President, effectively advance basic researches intended for the integration of fields and the exploration of areas in view of the solution of issues by means of collaborations in the entire agency mainly among researchers who have outstanding research histories, insight and strong leadership. Core researchers are required to produce creative outcomes toward the solution of diversified issues faced by Japan and to play an important role in integrative researches which are turned into the exploration of new research areas and the fostering of research fields. Furthermore, RIKEN is required to contribute to breakthroughs in science and technology and socioeconomic development by conducting advanced integrative researches ahead of other research and development agencies with the use of a wealth of knowledge and creativeness of core researchers and by addressing social issues which are more difficult and complicated than ever. Moreover, RIKEN shall steadily lead individual research and development projects into the exploration of research areas through checking and appropriately verifying their progress. If the necessity or priority of any research and development project has decreased, because its objectives have been achieved, or in the light of scientific impacts and social needs, it shall be strictly reviewed as needed	

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	including its discontinuance. Moreover, RIKEN shall swiftly respond to projects whose need has increased in view of different circumstances.	
	4. Effective use of research and development outcomes for the benefit of society by means of strategic and focused collaborations of establishment of networks The utilization of research and development outcomes for the benefit of society by developing seeds produced by researches and creating public values and innovation is one of important and fundamental missions to be implemented by a national research and development agency. Therefore, RIKEN conducts research and development at all times with an awareness of social needs as well as output and outcomes toward society and actively contributes to society by means of the promotion of industry-academia-government collaborations, strengthening of its planning and designing functions and development of its systems therefor and strategical acquisition, exploitation and management of intellectual property. RIKEN is committed to open innovation together with universities and private businesses for the purpose of creating and disseminating the world's highest level of research and development outcomes and their practical application. As for technology transfer for industrial and medical application, RIKEN sets priority research agendas in such fields as drug discovery and energy and strengthens its system to effectively facilitate cross-sectional collaborations in the agency with the aid of potentials RIKEN's research infrastructures have. Moreover, RIKEN effectively and systematically promotes technology transfer through collaborations with other national research and development agencies, businesses and medical institutions and the establishment of networks therewith. Furthermore, it is vital to improve RIKEN's competitiveness by	

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	strategically acquiring and maintaining patents with the objective of effectively translating intellectual property owned by RIKEN into practical application and to actively provide support for commercialization in cooperation with related organizations. Also, RIKEN shall examine whether patents whose necessity is low should be maintained through verifying patents owned thereby with the aim of further improving the patent working rate and shall establish a system to unfailingly advance this review. As a part of this initiative, RIKEN shall endeavor to increase revenues from patent working fees.	
	5. Developing research environments and nurturing and producing talented researchers RIKEN shall, as a research and development agency where world-class researchers gather, produce a number of outstanding research and development outcomes in view of sound development through further developing and improving its research environments open to the world in terms of both software and hardware, and continue to be a research and development agency counted on and respected on a global scale as a base for the cycle of brains by means of fostering and producing talented human resources (1) Developing open and vibrant research environments In order for RIKEN to occupy the position of the world's top research and development agency, it is important that it becomes a hub of the cycle of talented brains inside and outside of Japan. It is also required for RIKEN to prepare for vibrant research environments so that talented researchers including young, female and foreign researchers are actively employed. To be specific, RIKEN shall take such initiatives as; • strategic and swift research and development; • creation of competitive research environments; • improvement of research incentives toward the creation of	

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	achievements; • establishment of internationally-opened research system; • employment of young researchers and creation of challenging research opportunities; and • development of research environments where female researchers play an active role, for the purpose of promoting the reform of advanced research and development systems ahead of other organizations. (2) Nurturing and producing human resources who have internationally distinguished capability In order for RIKEN to grow as a world-class R&D agency and to gain expectations and respect on a global scale, it is crucial that talented researcher who have distinguished capability from all over the world are attracted to RIKEN and talented researchers who can play a leading role on various domestic and overseas research stages are produced. To this end, RIKEN shall endeavor to further refine the development of its system which should be a global hub of the cycle of brains of researchers and of its research environments that are responsible for the world's highest class and challenging research and development and provide next-generation engineers and young researchers with appropriate support to foster them so that conducting researches at RIKEN becomes a part of attractive career path for talented domestic and foreign researchers. (3) Transmitting information on research and development outcomes in an easy-to-understand manner and enhancing the understanding on research and development activities In some cases, it may be difficult even for persons who are familiarized with science and technology to a certain degree to	

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	sufficiently comprehend the contents and significance of research and development conducted at RIKEN, because researches often relate to cutting-edge science and technology. It is important to actively present R&D achievements in the form of papers, study meetings, symposiums, public relations magazines and facilities open days, as they have done before as researchers of the world's top research and development agency. It is also important to gain support from citizens by helping them to deepen their understanding on the significance of conducting such researches through transmitting appropriate and specific information on expected achievements from those researches and the benefits brought to society in an easy-to-understand manner. Moreover, it is of importance to transmit information to other countries. To this end, RIKEN shall promote strategic public relations and outreach activities from FY2013 by incorporating a variety of viewpoints with the participation of external experts. (4) Cooperating and collaborating with domestic and overseas research institutes Issues which mankind face such as environment, energy, food and infectious diseases cannot be addressed only by Japan. All countries in the world must cooperate and work together to tackle them. Furthermore, it is vital for Japan to generate synergy with diplomacy through promoting international collaboration and cooperation from the aspect of scientific and technological innovation. Collaborations with domestic and overseas research institutes and the establishment of overseas research centers are important not only from the viewpoint of further strengthening its own	

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	research and development capability but also from the viewpoint of contributing to the solution of these issues and the promotion of scientific and technological diplomacy. Therefore, RIKEN shall strategically promote those initiatives. An overseas research and development center shall be closed as soon as a joint research terminates. (5) Strengthening the function of strongly supporting research and development activities from the administrative and technical sides It is important to obtain specialized knowledge and practical abilities concerning various systems and techniques on legal affairs, personnel affairs and accounting from diversified points of view through paying attention to opinions of external sources in order to engage in challenging R&D activities under the world's highest level of open research environments, produce creative outcomes and effectively use them for the benefit of society such as industrial and medical application. Thus, RIKEN shall systematically establish its organization and systems to strengthen the research support function. Moreover, it takes initiatives for creating an environment in which researchers can concentrate on their researches through securing research supporters and assigning specialists for management and exploitation of intellectual property Furthermore, it is expected for the Research Support Department not only to provide researchers with support but also to play a role in supporting appropriate management judgment of RIKEN so as to advance R&D activities in an effective and organized manner toward the solution of national policy issues. In addition, it is important to actively cooperate in forming networks to improve research environments of universities, etc., with the aim of utilizing the strengths of human resources who	

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	support research in various scenes of research and development and producing outstanding outcomes.	
	6. Promotion of Initiatives for Appropriate Business Operations Strategic corporate operations are essential in order to produce outstanding achievements as the world-class research and development agency. To achieve this goal, it is of importance to secure an operational system which allows the President to fully demonstrate the leadership and a system in which the leadership and judgments of the President are supported by diversified knowledge and experiences. RIKEN shall, therefore, establish effective, efficient and proper business operations systems of the entire agency under the appropriate share of responsibilities and authorities, enhance and strengthen internal control, and ensure a budget implementation system under which RIKEN can be operated and managed flexibly and swiftly. The RIKEN's operations are managed by a large amount of public funds. From this point of view, it is vital to strive to increase the RIKEN's raison d'etre and values in society at all times as is the case with other incorporated administrative agencies. (1) Response to national policies and guidelines as well as social needs Under the clear missions toward the accomplishment of policy issues, RIKEN shall, as a core player of the research and development functions of Japan, actively and independently engage in research and development in an organized manner based on innovation policies for science and technology such as the Science and Technology Basic Plan and promote strategic and focused research and development in response to various social needs. Additionally, if any innovative knowledge about science and technology is found or any significant change in national or international circumstances occurs in the science and technology field and the Minister of Education, Culture, Sports, Science and	

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	Technology makes a request to conduct research and development on the knowledge or to take any other measure, RIKEN shall swiftly respond thereto. Furthermore, RIKEN shall endeavor to collect and analyze information on global trends of science and technology, research visions, effectiveness of research and development outcomes, social circumstances and social demand through maintaining regular contact with cultural science and social science and appropriately reflect them in its own R&D activities. (2) Compliance and maintenance of the ethics It is required for RIKEN to take appropriate actions such as serious compliance with various rules as “RIKEN in society” in order to gain expectations and respect from society and grow as a global research and development agency for science and technology. RIKEN needs to make further efforts for widely raising awareness on compliance in the organization before research and development outcomes are translated into medical and industrial applications. It is of extreme importance that not only individual researchers but also RIKEN as a whole is aware of research misconduct, misuse of research expenses, maintenance of ethics and compliance. Therefore, RIKEN shall take thorough measures as a model for other research institutes and researchers through promoting the initiatives for raising awareness on prevention of research misconduct, clarifying the responsibilities therefor, and transmitting information on the progress of such initiatives to society. (3) Implementing appropriate research evaluations and reflecting their results Moreover, for individual research and development agendas and projects conducted in RIKEN, if the necessity of conducting them in	

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	RIKEN has decreased, because their objectives have been achieved, or their priority has decreased in the light of scientific impacts and social needs, they should be strictly reviewed as needed including their discontinuance. Also, RIKEN must respond to projects whose need has increased in view of different circumstances. Furthermore, RIKEN shall take a reasonable response, due to the characteristics of research and development, in case where it is appropriate to continue a business after modifying its original goal taking into account unexpected results or achievements obtained in the research and development process and global trends of research and development. RIKEN shall, therefore, appropriately make evaluations on research and development agendas, projects and research operations at an appropriate time and disclose results thereof through introducing world-class evaluations based on global points of view which reflect opinions from foreign researchers, evaluations with the mindset of the general public based on its opinions, and external evaluations made by experts, and reflect them in a desired way of future research and development in an appropriate manner. When any research is evaluated, consideration should be given so that creative, prospective and talented researchers and researches are explored or further developed. (4) Promotion of information disclosure RIKEN shall actively disclose information by ensuring appropriate operations and making its activities known to the wide public for the purpose of deepening the understanding and trust of citizens. Care should be taken, in particular, to ensure transparency in contracted businesses taking into account various circumstances surrounding incorporated administrative agencies.	

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4. Matters concerning efficient operation and management 4.1 Streamlining and improving efficiency of operational expenses Operational expenses will be streamlined to increase efficiency by reviewing the organization, streamlining procurement, and assuring efficient operational systems. For the projects supported by operating expenses grant, efficiency for the total amount of general administrative expenses (excluding personnel expenses and public dues) and other operating expenses (excluding personnel expenses) will be improved by xx% on an average in every fiscal year compared with the preceding fiscal year with newly added or expanded expenses and special expenses (e.g. xx) excluded. The newly added and expanded expenses will be contained in this calculation from the next fiscal year. 4.2 Appropriateness of personnel expenses Necessary measures for fostering and securing outstanding researchers and research assistants will be taken by reserving a suitable amount of personnel expenses according to the government policies. Wages of administrative and general staff including allowances will be strictly examined with reference to the wage level of national public officers to maintain an appropriate level based on the specific characteristics of assigned tasks, and examination results and process of examination will be made public. To obtain internationally outstanding human resources, their wage will be set as required in a flexible manner, and satisfactory explanation will be provided to the public. 4.3 Streamlining of procurement and appropriateness of contract Efforts for assuring fair contact and transparency will be promoted pursuant to the “Policy for Streamlining Procurement by Incorporated	IV. Matters concerning Streamlining and Efficiency of the Operation of Business RIKEN shall be committed to improving its business operations by adding originality and ingenuity. RIKEN shall make efforts for reviewing necessary projects and develop systems so that each project is carried out efficiently and rationally and for streamlining and improving business efficiency by means of informatization and other measures. RIKEN shall be committed to improving business efficiency for the total amount of general administrative expenses (excluding personnel expenses, special expenses and taxes and public dues) and other operating expenses (excluding personnel expenses and special expenses) by more than 1.03% in every business year during the mid to long-term objective period with newly added or expanded expenses excluded. For a period from FY2013 to FY2016, this shall be based on the “efforts for reducing general administrative expenses (excluding special expenses and taxes and public dues) by more than 15% and improving business efficiency in every business year by more than 1% concerning other business expenses (excluding special expenses) in the mid to long-term objective period” specified in February 2013. When any business is reviewed or streamlined in response to system improvement, RIKEN shall pay careful attention so that past research and development outcomes, facilities and human resources can be utilized effectively and efficiently for future activities and promote appropriate information security measures based on the government’s policies. RIKEN shall effectively promote the streamlining and improvement of efficiency of its business operations with the aid of the development and upgrading of its information systems after clarifying their results specifically and quantitatively in the mid to long-term plan. The total personnel expenses should be reviewed strictly based on	

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Administrative Agencies" (decided by the Minister of Internal Affairs and Communications on May 25, 2015) to improve the efficiency of operation. Auditors or accounting auditors shall completely check the appropriateness of bidding and contract during audits.	the government's policies. RIKEN shall, as one of core players responsible for the research and development functions of Japan, take these measures giving due consideration to the fact that it is expected for RIKEN to actively contribute to the accomplishment of policy issues set out in the Science and Technology Basic Plan and to research and development in response to a variety of social needs without betraying the expectations from citizens.	

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5. Matters concerning improvement of financial conditions RIKEN will strive to reduce expenses through efficient budget implementation, and actively obtain, increase and utilize self-generated income such as external funds facility usage fees, contributions and patent licensing fees, and external funds such as competitive funding while considering the appropriateness of the beneficiaries-pay principle of patent licensing fees. Budgets will be implemented according to plan by considering outstanding obligation of operating expenses grant. The assets recognized as unnecessary will be disposed in a proper way, and critical properties transferred systematically.	V. Matters concerning improvement of the composition of finances 1. Efficient and proper implementation of budgets RIKEN shall establish a system to efficiently and properly implement its budgets. Moreover, care should be taken to the status of accrual of the total amount of debts for the government funding for operation in calculating the annual amount thereof. 2. Reduction in fixed costs and expenses RIKEN shall strive to reduce its costs and expenses through intending to efficiently operate its facilities. 3. Securing of sponsored funds RIKEN shall strive to secure sponsored funds such as competitive research funds, contributions and patent right revenues.	
6. Other important matters concerning administrative operations 6.1 Enhancement and strengthening of internal control Internal control will be enhanced and strengthened by improving the effectiveness of compliance systems under the leadership of the president, in close collaboration with auditors based on the audit plan from mid to long-term perspectives, and by carrying out systematic and efficient internal audits and utilizing audit results effectively pursuant to the “Internal Control and Evaluation of Incorporated Administrative Agencies” (Research Report on the Internal Control and Evaluation in Incorporated Administrative Agencies in March 2010), etc. In particular, evaluation and analysis of risks causing obstructive factors for the agency to accomplish missions, and appropriate measures including prevention of research misconduct and illegal use of research funds will be promoted. 6.2 Legal compliance and maintenance of the ethics	VI. Other Important Matters concerning the Operation of Business 1. Matters concerning facilities and equipment RIKEN shall effectively utilize the existing research space and systematically modify, upgrade and maintain its facilities and equipment including countermeasures against their deterioration to maintain favorable research environment based on the long-term prospects of future development of and demand for researches. RIKEN shall also effectively utilize its facilities and equipment to the extent possible by promoting shared use thereof. RIKEN is required to appropriately dispose the Itabashi Branch for which a decision of abolishment has been made during the period for mid to long-term objectives and return the amount of revenues generated thereby to the national treasury. Moreover, RIKEN shall undertake the procedures for any lodging for its employees for which a decision of abolition has been made, by giving sufficient consideration to smooth move of residents. 2. Matters concerning personnel affairs	

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Awareness of legal compliance and the ethics will be improved in carrying out missions to return R&D outcomes to society to maintain reliability by the public. In particular, complete observation of the "Guidelines for Responding to Misconduct in Research" (decided by the Minister of Education, Culture, Sports, Science and Technology on August 26, 2014), etc. will be promoted to prevent research misconduct and illegal use of research funds in research activities, and appropriate operations will be continued according to the action plan launched by RIKEN for recurrence prevention. Efforts serving as the model for other research institutes will be proceeded by improving researchers' awareness of research misconducts and disclosing RIKEN's efforts to prevent research misconducts to the public. 6.3 Securing safety in work Safety will be sufficiently taken into account during work, and occupational safety and health management will be thorough according to related laws and regulations to prevent accidents caused by work and carry out operations safety and smoothly. 6.4 Promoting information disclosure Information will be disclosed properly and actively pursuant to the "Act on Access to Information Held by Incorporated Administrative Agencies" (Act No. 140 of 2001) to maintain appropriate operational management and public reliability. 6.5 Improving information security Based on the "Common Standards of Information Security Measures for Government Agencies" (decided by the Cybersecurity Strategic Headquarters on August 31, 2016) developed pursuant to the Basic Act on Cybersecurity (Act No. 104 of 2014), ability of RIKEN	RIKEN shall endeavor to secure talented personnel, improve their capabilities and enhance incentives for duties carried out thereby through appropriate evaluations and treatment. Also, RIKEN shall actively utilize fixed-term employees and promote the introduction of the cross-appointment system with the aim of building vibrant and open research environments. 3. Rationalization of wage levels As for the wage levels (of administrative and technical staff), RIKEN shall verify them based on the following points of view, and if there is no reasonable ground for maintaining them, immediately take initiatives for rationalizing the wage levels through taking necessary measures, and disclose the verification results and the progress of such initiatives. Moreover, RIKEN shall secure human resources who have internationally distinguished capability for any business that needs to be carried out particularly with the aid of the world's highest level of advanced and specialized knowledge and experiences taking into account the payment standards for remuneration and wages. 1) Whether the wage levels are not higher than those of national public officers even though such factors as the forms of employment, locations of work and academic background of employees are taken into consideration; 2) Whether there is any room for correction of factors of high wage levels (for example, the rate of management-level employees in relation to non-management level employees is high); 3) Whether RIKEN can give sufficient explanations about that the current wage levels are appropriate in the light of the large amount of government expenditures, the existence of cumulative deficits and the wage levels of private businesses that engage in similar business.	

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to respond to external attacks and internal information leaks will be improved with concerted efforts throughout the agency by improving a system of taking suitable measures and providing information security measures according to this system to strengthen the capability of defense for the cyberattack to the information system. The implementation status of measures will be reviewed every fiscal year, and issues pointed out in audits conducted by the Cybersecurity Strategic Headquarters will be steadily solved by means of constant improvement of information security measures using the PDCA cycle. 6.6 Matters concerning facilities and equipment RIKEN will effectively utilize the existing research facilities and those which are scheduled to be developed in the mid to long-term objective period to maintain a good research environment in light of the future development of research and long-term perspectives on demand, and systematically modify, upgrade and maintain its facilities and equipment including countermeasures against their deterioration. 6.7 Matters concerning personnel affairs The term of fixed-term staff and personnel system reformation will be steadily promoted with the balance between the mobility and stability of human resources in mind to maximize R&D outcomes and conduct work effectively and efficiently. A cross-appointment system will be used to keep diversified and outstanding talents, improve capability of staff and increase incentives of staff for assignment with appropriate evaluation and treatment.	4) In addition, whether the wage levels can be explained sufficiently in a way that they are accepted by citizens. 4. Review of contracted business RIKEN shall strive to effectively and swiftly procure goods and services based on the fact that research and development are conducted under international competition and develops a necessary system for appropriate implementation thereof. In principle, general competitive biddings shall be used for concluding contracts, and RIKEN shall promote the rationalization of discretionary contracts by means of the following initiatives: 1) RIKEN shall strive to effectively and swiftly procure goods and services based on the fact that research and development are conducted under international competition and develops a necessary system for appropriate implementation thereof. In principle, general competitive biddings shall be used for concluding contracts, and RIKEN shall promote the rationalization of discretionary contracts by means of the following initiatives: 2) Even if a contract is concluded by general competitive bidding, to adopt a method which allows competitiveness and transparency to be ensured sufficiently, particularly where competition or public offering is used. Moreover, RIKEN shall conduct through checks on proper implementation of biddings and contracts in audits conducted by auditors-secretary and accounting auditors. 5. Securing of safety of business It is required for RIKEN to give heed to safety when it conducts any business.	

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(Deleted)	[Appendix 1] Promotion of strategic and focused research and development based on national and (1) Emergent matter science In order to create green innovation with the help of environmental and energy technologies which Japan has advantage over and to be the most advanced nation in environment and energy ahead of the world, it is necessary to establish new academic theories capable of bringing about breakthroughs in energy use technologies based on a completely new concept different from existing science and technology beyond the limit of performance improvement which cannot be surpassed only by being built upon existing technologies. Therefore, RIKEN shall promote researches on matter science with a focus on physical properties or functions (emergent matter) which cannot be explained as a mere assembly of individual constituents such as electrons spins and molecules which solid/molecular assemblies and nano-devices can present. This field is expected as the third field that may bring about the third energy technology innovation next to steam energy technology innovation and nuclear energy technology innovation, and attracts international attention. RIKEN is expected to establish emergent matter science as a new research field ahead of the world, and attract national and foreign researchers to RIKEN which has played a leading role in research and development on this field with the objective of improving the scientific and technological levels of Japan. Moreover, it is required to establish new world-class R&D centers for matter science to promote research and development in this field. RIKEN shall create new matter science and conduct research and development related to device technologies that revolutionary reduce power consumption and convert energy with high efficiency. To be specific, RIKEN aims to establish high-efficiency thermoelectric conversion techniques capable of effectively exploiting	

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	mid or low-temperature unused heat and ultralow-power consumption electronic device technologies surpassing semiconductors by the 2020's with the aim of leading them into industrialization in the 2030's. To this end, RIKEN shall produce world-class outcomes related to energy use innovation in the period for mid to long-term objectives through developing new strongly correlated thermoelectric materials whose performance exceeds the maximum performance which has not been surpassed over the past half century. Moreover, RIKEN shall promote the nurturing of human resources who have higher and international visions and lead next-generation researches on emergent matter science in collaboration with domestic and overseas research institutes, universities and businesses and the comprehensive initiatives for examining trends of related projects and social needs of private businesses, etc., and converting cutting-edge research and development outcomes into the basis for future industrial technology development. (2) Sustainable resource science The cyclic use of environmentally-friendly resources and energies is indispensable to address global issues such as securing of resources, environmental preservation and increase in food production and to realize a sustainable society. RIKEN shall, with the aim of realizing these goals, promote advanced researches which integrate plant science, microbial chemistry, chemical biology and synthetic chemistry based on the understanding on diversified bio-functions and chemical functions with a view to cyclically using such resources as carbon which continues to be consumed as petrochemical products, nitrogen which is indispensable for life activities and rare metal elements. RIKEN is also required to conduct research and development in view of technological	

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	innovation capable of producing industrially-useful resources with high efficiency by use of bio and chemical processes so that they can be utilized in industry in the 2030's. For example, RIKEN is expected to intend to realize ammonia synthesis from nitrogen and hydrogen which consumes less resources and energy, by the 2020's. This method may innovate the Haber-Bosch process which is considered as one of the greatest inventions in the 20th century. To be more specific, RIKEN shall conduct research and development under the following objectives. To establish techniques to efficiently fix CO_2 and nitrogen as raw materials with the help of plants or catalysts in order to reduce the usage of fossil resources through the cyclic use of air resources including carbon and nitrogen; to clarify a mechanism related to the fixation function of plants and develops innovative catalysts as well as environment-friendly chemical-reaction techniques which convert compounds containing fixed carbon or nitrogen into useful materials: To clarify useful factors which involve in environmental tolerance and the growth function of plants and develops techniques to improve those functions toward the development of plants which can show high growth under the conditions that water and fertilizers are rarely available: To develop low-cost and high-efficient innovative material production techniques capable of environment-friendly and efficient collection of resources in order to stably securing resources without being affected by the world affairs in Japan which counts on little natural resources: To efficiently collect resources from so-called "urban mines," identify living organisms capable of efficiently collecting heavy metals in contaminated areas and clarify their functions; to bring about highly-efficient and selective chemical reactions by developing innovative metal complex catalysts by use of unique characteristics of	

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	individual metal elements. RIKEN shall endeavor to upgrade fundamental technologies by building a world-class metabolome analysis infrastructure and by enhancing and integrating the natural chemicals banks as well as promote more than ever the initiatives for providing domestic and overseas research institutes with collected chemicals. RIKEN shall examine trends of related projects and social needs of businesses in cooperation with domestic and overseas research institutes, universities and businesses to effectively conduct researches and foster talented personnel in the field of sustainable resource science. (3) Brain science The brain science research is integrated science which constitutes the basis for the understanding on humans beyond the traditional boarders of natural science and humane/social science. Its achievements have scientifically-important values and greatly contribute to social, economic and cultural development In recent years, the response to mental and neurological diseases has become important in society along with changes in social environments such as aging. Therefore, research and development to combat these diseases is expected. RIKEN shall, as a core research and development agency for brain science in Japan, conduct concentrated and strategic researches taking discussions at the Brain Science Committee established under MEXT into consideration. Moreover, RIKEN is expected to comprehensively promote brain science through developing and taking advantage of fundamental technologies which bring about breakthroughs in brain science and comparing “brain function in the healthy state” with “those in the disease state” based mainly on neural function analysis.	

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	For researches to combat diseases, RIKEN shall present new drug discovery targets and therapeutic ideas for mental and neurological diseases such as dementia with a view to applying them to clinical trials. RIKEN shall clarify the neural circuit functions and the brain functions in the healthy state as basic information on diseases and continues to transmit information on its research and development outcomes by means of internationally-appreciated academic journals. In the field of the development of fundamental technologies which support those researches, a support shall be provided by disseminating developed technologies to researchers of brain science nationwide by mean of industrial application. It shall be aimed to understand how the brain and the mind function, through conducting these researches, reforming its systems under effective management and conducting academic studies in the respective stages of molecule, synapse, cell, circuit, system, behavior and society. Moreover, RIKEN shall endeavor to disseminate research and development outcomes and fundamental technologies by conducting researches in organic collaboration with domestic and overseas universities, related organizations, businesses and educational institutions as well as foster next-generation researchers specialized in brains science. RIKEN is committed to maintaining its position as one of the world's best R&D centers for brain science by continuing to transmit information on cutting-edge innovative research and development outcomes to the international brain science community. (4) Developmental biology The developmental biology is in an academic field consisting of the basic science aspect for the purpose of clarifying the basic principles	

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	for life and the application aspect for the purpose of directly connecting their outcomes to the progress of advanced medical care including regenerative medicine and the identification of disease mechanisms. The society places high hopes on this field. It is expected, in particular, that researches on regenerative medicine to produce as many successful cases as possible in view of early practical application of iPS cells. Under such circumstance, it is of extreme importance for RIKEN which has played a core role in regenerative medicine to continue to lead this research field. Therefore, RIKEN shall set clear goals to be achieved and quantitative goals for each research area as a core R&D center for regenerative medicine in Japan, and aim to establish the infrastructures for researches on the principles for generation and for applied technologies based thereon in accordance with the government's policies for this field. As for basic researches, RIKEN is committed to understanding the mechanisms of embryonic development and formation of organs at the genetic, cellular and organizational levels and specifying the underlying principles that multiple cells generate complex structures and functions as a group. In particular, RIKEN is expected to clarify the "control mechanisms of size and shape" by introducing new techniques such as mechanical analysis of the formation of organs and the establishment of mathematical models thereof. Moreover, RIKEN shall, by applying these operational principles, establish an innovative fundamental technology system capable of providing advanced regenerative medicine for example the in-vitro production of diversified steric organs from stem cells such as iPS cells. Specifically, RIKEN shall develop such tissues as the pituitary and lens similar to living organisms by FY2015 and artificial tissues which replicate human clinical conditions in the mid to long-term objectives.	

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	Additionally, RIKEN shall initiate a clinical research on treatment of age-related maculopathy by means of transplantation of retinal pigment epithelial cells within 12 to18 months after it is approved by a RIKEN's ethical review and a government's review to create a pioneer case of the application of regenerative medicine utilizing iPS cells, as well as aim to carry out clinical trials toward their use for general treatment in collaboration with medical institutions through improving safety and quality management techniques in an organic and multifaceted manner. Finally, RIKEN shall endeavor to disseminate research and development outcomes and fundamental technologies in organic collaboration with domestic and overseas universities, research institutes and businesses as well as smoothly and unfailingly apply basic researches on developmental biology to regenerative medicine and other fields. (5) Life science research In the fourth Science and Technology Basic Plan, the research on life dynamics system science is considered to realize safe and effective treatment and significantly contribute to the creation of various types of life innovation such as regenerative medicine, development of new medicines and prediction of clinical conditions. In order to clarify how the complex life system controls itself, an integrative technique beyond traditional life science is required. Since researches on such technique have accelerated on a global scale, those in RIKEN will contribute to the strengthening of international competitiveness of Japan. In this situation, RIKEN is required to promote life system researches, for viewing life as a system, capturing complex ever-changing life phenomena from both theory and calculation, and predicting, controlling and reconfiguring such phenomena.	

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	Organic collaborations between researchers who have diversified backgrounds such as biology, information science, engineering and physics shall be promoted in study fields of cellular kinetics measurement, life modeling and cell design. RIKEN shall develop techniques for quantitative measurement and analysis in each layer of life phenomena with a central focus on cells and quantitatively capture the ever-changing state of cells for the purpose of clarifying a mechanism of unique emergence functions thereof. Moreover, it shall aim to quantify the state of complex systems based on measurement results and to replicate the cellular dynamics from the molecular level through establishing a model thereof based on quantitative understanding and simulations. Furthermore, with the aim of verifying results obtained from cellular dynamics measurement and life modeling through reconfiguring them by use of experiments, RIKEN shall develop fundamental technologies to adjust, design and control life parts such as genes and proteins. The integration and cycle of these researches will accelerate the initiatives for clarifying and controlling the operational principles for life systems. In addition, RIKEN shall endeavor to disseminate research and development outcomes and fundamental technologies in organic collaboration with domestic and overseas universities, research institutes and businesses as well as foster human resources in this research field to promote the mid to long-term development (6) Integrative medical sciences Humans have a mechanism of maintaining their body conditions to constant state at all times called biological homeostasis even when they are exposed to changes in external factors. Cooperative behaviors of the immune system, endocrine system and mental and neurological	

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	systems integrally play such a role on the background of dynamic changes in biomolecules. The clarification of the homeostatic mechanism helps us to understand the root of life functions and reveals the process leading to collapse of the mechanism to maintain homeostasis, that is, “disease.” Since this clarification contributes to tailored medical care, it draws great expectations from society. In order to accelerate the initiatives for realizing tailored medical care and preventive care, RIKEN shall integrate and develop achievements obtained from the clarification of the basic principles of the immune system in comprehensive researches on immunology and allergy science, the development of fundamental technologies such as humanized mice and the comprehensive identification of a large number of humane disease-related genes by extensive use of genome analysis techniques in researches on genome medical science which were conducted in the previous period, and conduct a new field of research called integrative medical science. As a part of researches on integrative medical science, RIKEN is expected to contribute to the realization of next-generation tailored medical care and preventive care through establishing a genome analysis research infrastructure, clarifying the maintenance of life homeostasis taking human diversity into consideration and the process of onset of diseases caused by its breakdown on a multi-layer basis, and promoting the search for disease onset predictive markers to predict or prevent disease risks which has been impossible in past elementary researches. Specifically, RIKEN shall establish a system to integrally measure specimen on a multi-layer basis by FY2014, a system to extract networks of the underlying functions of homeostasis using modeling by FY2016, and a database covering more than 1% of gene polymorph of genomes of the Japanese nation in this period for mid to long-term objectives for the purpose of verifying disease onset models and	

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	identify disease onset predictive markers and candidate treatment targets. Moreover, the fundamental technologies to comprehensively search for disease-related genes and to conduct immunization researches shall be upgraded. Furthermore, RIKEN shall strive to disseminate research and development outcomes and fundamental technologies in organic collaboration with domestic and overseas universities, research institutes and businesses (7) Advanced photonics The advanced photonics is expected to contribute to innovative manufacturing based on the clarification of underlying principles and the creation of science and technology innovation in various fields such as life science and information and communications. Moreover, it detects dangers and abnormalities which exist in proximity to us beforehand and greatly contributes to the realization of safe and secure society by solving such issues faced by Japan as safety measures for deteriorating social infrastructures and natural disasters as well as environmental preservation and by bringing about great breakthroughs in medical and diagnostic techniques. Building upon these initiatives, RIKEN shall gather advanced radiation sources and element technologies developed in the past with the objective of visualizing various phenomena which could not be observed in the past and, in collaboration with universities and research institutes, conduct researches on the development of ultrahigh-speed precision measurement techniques which observe movements of electrons, atoms and molecules in substances indispensable for developing new materials in attosecond and super-resolution imaging and monitoring techniques which observe deeper parts of body tissues on a real-time basis as well as the upgrading of generation and control	

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	techniques aiming at downsizing of devices toward practical application of terahertz lights which are expected to be used in industry in various forms such as diagnosis of breakdown of integrated circuits and tests of the existence of foreign bodies. RIKEN shall lead advanced photonics researches conducive the solution of important social issues through conducting researches designed for the practical application of techniques to be developed through the above researches in collaboration with researchers and businesses in diversified fields. Before conducting these researches, RIKEN shall narrow down social issues to be solved thereby and clarify high priority issues among them in FY2013 so that researches conducive to the solution of those issues are conducted in a focused manner. Moreover, RIKEN shall foster specialists of science and technology who play a central role in future advanced photonics thorough those initiatives. (8) Information science and technology In recent years, new knowledge is being created from an enormous volume of data in response to the dramatic expansion of networks and the use of cyberspace due to the progress of information and communication technology (ICT), and innovation is created in various forms. It is required for Japan to create added values from big data in order to form an ultra-smart society ahead of other countries in the circumstance where the use of IoT (Internet of Things) has been expanding. To this end, it is indispensable to conduct researches mainly on innovative artificial intelligence techniques that support, in particular, IoT, big data analysis and advanced communications and research and development on next-generation fundamental technologies in view of experiments and practical application.	

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	Based on the decisions made by the cabinet in response to reports of the Council for Science, Technology and Innovation and the Headquarters for Japan's Economic Revitalization, RIKEN shall, through exploiting its characteristics as a comprehensive research agency for general natural science, establish a new research center for innovative artificial intelligence (AI) techniques. Moreover, from the viewpoint of promoting global collaborations and competition, the collective strengths of universities and research institutes in Japan shall be gathered together and RIKEN shall promote research and development through active collaborations with overseas universities, research institutes and industry. To be more specific, RIKEN shall develop innovative fundamental technologies for artificial intelligence learnt from the underlying principles for human intellectual activities and drastically develop science in multiple fields by means of artificial intelligence and big data. By this way, RIKEN can contribute to the implementation of those technologies in society in many applicable areas which create specific socioeconomic values as well as solve ethical and social issues where the use of artificial intelligence spreads and foster data scientists. RIKEN shall find a clue to research and development of innovative AI techniques in this period for mid to long-term objectives and produce outcomes conducive to specific implementation in society. Moreover, it shall promote the initiatives for extracting issues in the relationship between AI and society and for fostering data scientists toward the realization of an ultra-smart society.	
(Deleted)	[Appendix 2] Promoting development and shared use of the world's highest level of research infrastructures and promoting researches using such infrastructures (1) Accelerator-based science In this research area, RIKEN shall aim to clarify the mysteries	

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	relating to the creation of materials by discovering the reality and nature of atomic nuclei and elementary particles which constitute them and advance the application of atomic nuclei and elementary particles to such industries as agriculture, engineering and medicine taking advantage of the RI Beam Factory (RIBF), which is the world's best heavy-ion accelerator facility. Moreover, RIKEN gathers researchers from Japan and other countries by means of joint researches and shared use to produce outstanding achievements. RIKEN shall maintain the facilities and upgrade the strength of beams generated by the RI beam generation system 3-fold with the aim of smoothly promoting researches in this field. Furthermore, research agendas for actively promoting joint researches and shared use shall be fairly selected. As for industrial application, RIKEN is required to promote researches on plant breeding and enhance systems to expand industrial application such as product evaluation. RIKEN shall, through collaborations with other organizations in the form of international collaborative researches based on science and technology cooperation agreements between nations, clarify the origin of proton spins and obtain knowledge to realize new material research. Through these initiatives, RIEKN shall enhance its collaborative systems with domestic and overseas organizations in terms of both experiment and theory, form an international center for the cycle of brains in the fields of nuclear physics and particle physics and foster human resources who can contribute thereto. (2) Research on synchrotron radiation science RIKEN shall, based on the Act on the Promotion of Public Utilization of the Specific Advanced Large Research Facilities (Act No.78 of 1994), be responsible for operations and public utilization of	

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	the specific synchrotron radiation facilities (the large synchrotron radiation facility (SPring-8) and the X-ray free electron facility (Angstrom Compact Free Electron Laser named SACLA)) in close cooperation with registered institution for facilities use promotion specified in this Act taking into account the needs of users. Moreover, as the world's only organization that counts on the two facilities, RIKEN is committed to developing advanced radiation sources and use technologies which exploit their characteristics to the maximum extent possible and comprehensively promoting the development and establishment of advanced use systems which integrate use technologies and the exploration of new research areas. These initiatives help RIKEN to play a role as a research and development infrastructure for synchrotron radiation science conducive to the solution of various social issues. In particular, RIKEN shall allow users to have access to SPring-8 around 80% of its annual operating time and aim to realize the theoretical brightness limit of radiation sources and a 20% or more energy saving. RIKEN shall also improve beam stability at the nano-level and realize three-dimensional imaging analysis and this technique will be provided to users. As for SACLA, RIKEN shall aim to make it available to users around 70% of its annual operating time through reducing adjustment time and promote researches conducted by use thereof through upgrading beams by means of the seeding technique and establishing an imaging technique of transient phenomena at the atomic level. Toward the production of the world's highest level of achievements, RIKEN shall promote collaborations between SPring-8 and SACLA and organic collaborations with the super-computer (K Computer), other facilities related to radiation science technology and quantum beam, universities and research institutes, as well as the development	

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	of human resources who contribute to researches on synchrotron radiation science with the aim of further growing as the most advanced research development center in the world. (3) BioResource project Bioresources are essential research infrastructures for promoting innovation in science and technology, and their development and utilization greatly contribute to the solution of issues faced by Japan. In the BioResource business, RIKEN shall, as a core research infrastructure center for bioresources in Japan, endeavor to ensure “reliability,” “continuity” and “leadership” and efficiently and effectively develop and provide the world’s highest level of bioresources in response to social needs and research need, for example, by means of the development of disease-specific iPS cell resources in collaboration with government’s projects. In addition, RIKEN is committed to developing related fundamental technologies and improving the value of use so that they are utilized by users. Moreover, RIKEN shall bring forward the backup of bioresources which cannot be restored once they are lost and establish a preservation system being stable even in the event of any disaster. Furthermore, RIKEN is expected to play a central role among the resource centers in Asia as a leading research infrastructure center in the world, disseminate research and development outcomes and fundamental technologies and foster human resources in organic collaboration with domestic and overseas universities, research institutes and businesses. (4) Life science technologies Life phenomena caused by diverse biological molecules are a dynamic network system consisting of a large number of and a variety of elements. The clarification of its underlying operational principles	

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	brings about a dramatic breakthrough in science and technology to understand what life really is and greatly contributes to medical and industrial fields toward the realization of a prosperous society. Building upon this, RIKEN shall, in this project, push forward a technology infrastructure for researches on structural biology/synthetic biology, functional genome analysis and life function dynamic imaging, that is, a measurement technique at the atomic, cellular and individual levels on which Japan has an edge. Moreover, it shall integrate knowledge and these technologies to establish new technology infrastructures conducive to the promotion of next-generation life science research, drug discovery and medical care and utilize them in the initiatives for supporting drug discovery researches conducted by the academic sector in collaboration with related ministries and agencies. Specifically, RIKEN verifies drug discovery target molecules by use of the gene-expression network analysis technique, develops and upgrades an advanced technique to analyze drug discovery target molecules which are difficult to be analyzed and techniques to analyze biological pharmacokinetics and drug-drug interactions and techniques for drug discovery chemistry built thereupon. These techniques are utilized to provide support to research institutes such as universities and private businesses which have drug discovery seeds. Furthermore, RIKEN provides support for researches through developing and upgrading a new infrastructure for analyzing gene-expression networks with higher precision and quantitative performance and new techniques to design medicines which apply computational chemistry and conformational analysis technique. RIKEN shall, through these initiatives, aim to conduct around 300 joint researches and provide support for analyses in around 100 cases annually in this project with the aim of playing a leading role in research and development conducive to life science study in Japan as	

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	well as drug discovery and medical care. (5) Computational science A simulation conducted with the help of a supercomputer is a research technique as important as experiments and theories and makes a great contribution not only to the development of science and technology but also to designing and development of various products in industry. It is of extreme importance to gain an understanding of citizens and develop computational science and technology on a continuous basis in order to maintain and raising international competitiveness of science and technology and industries of Japan for the future. To this end, RIKEN shall appropriately operate, manage and maintain the specific high-speed computer facilities including the ultrahigh-speed computer (supercomputer "K") which is a core of the innovative High Performance Computing Infrastructure (HPCI) based on the Act on the Promotion of Public Utilization of the Specific Advanced Large Research Facilities (Act No.78 of 1994), and provide sufficient computational resources to researchers excluding a period required for maintenance, etc. Moreover, it shall develop a new (post "K") ultrahigh-speed computer in view of solving a variety of social and scientific issues which surround Japan aiming at the commencement of its operation by 2020. RIKEN shall conduct researches on upgrading of the specific high-speed computer facilities and intend to grow as a leading education center for state-of-the-art computing research through promoting the nurturing of human resources who engage in computational science and technology under the appropriate share of roles with the registered institution for facilities use promotion and other related organizations.	

Next mid to long-term objectives (draft)	Current mid to long-term objectives	Remarks (reason)
	In addition, an internal collaborative research system shall be established to develop breakthrough fundamental technologies toward the development of computational science and technology and to contribute to the promotion of research and development conducive to the solution of social issues such as energy issue through developing new applications based on those fundamental technologies. When these initiatives are taken, RIKEN shall strive to gain an understanding of citizens by appropriately transmitting information thereon as needed.	
(Deleted)	[Appendix 3] Effective use of research and development outcomes for the benefit of society by means of strategic and focused collaborations of establishment of networks As science and technology become more sophisticated and complicated and the rapid market globalization occurs, it is required to build innovation systems under strong industry-academic-government collaborations. Therefore, RIKEN is expected to play a part therein and take the initiatives for making use of research and development outcomes for the benefit of society though internal and external collaborations and the establishment of networks based on its advantage as a comprehensive research agency for general natural science. RIKEN shall carefully select innovative achievements produced thereby which are expected to evolve into the creation of next-generation technology infrastructures and practical application at an early stage and implement a program to effectively promote the transfer thereof to private businesses toward the exploitation in society. To be more specific, RIKEN forms a joint research team with private businesses and others so as to provide specialized and technical support to researches led by private businesses, and establishes a system within RIKEN to effectively support decision-making and enforcement of voluntary development by private businesses from the	

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	aspects of planning and proposal. Toward the realization of green innovation, RIKEN aims to create new industries based on innovative technologies capable of exploiting CO_2 as a resource by generating useful materials from biomass instead of petroleum in collaboration with related projects implemented in RIKEN and to widely spread them in society. Moreover, RIKEN intents to develop an effective system in which it plays a central role in inter-organizational collaborations and integration so that domestic and overseas universities, research institutes and private businesses can smoothly translate achievements of basic researches into industrial application through joint researches with the aim of establishing practical bio-processing technologies and creating a new industry based thereon. Also, RIKEN shall examine scientific and technical needs required by society and industry from the stage of basic research and promote open innovation aiming at the development of innovative technologies and systems. These initiatives help RIKEN to conduct research and development necessary for establishing innovative and consistent bioprocess with a view to creating new materials originating from plant biomass by FY2019. In this period for mid to long-term objectives, RIKEN shall draw a roadmap to the establishment of biological processes toward the creation of new materials and realize the introduction of element technologies thereof to industry. In order to realize life innovation, RIKEN makes use of the world's best research infrastructures such as SPring-8 and the super-computer K on a cross-sectional basis for creating innovative technology infrastructures optimized for drug discovery processes and techniques actually-exploited in medical fields. In this way, RIKEN shall translate these initiatives into innovative drug discovery and creation of medical technologies through providing comprehensive support for practical	

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	application of its infrastructures for disease researches in fields of brain science, cytogeneration and regeneration science and integrative medical science, and major seeds obtained from research and development achievements owned by research institutes including universities. Furthermore, RIKEN participates in initiatives for supporting researches on drug discovery conducted by the academic sector in collaboration with related ministries and agencies and provides support by use of the above technology infrastructure which cannot be provided by other organizations but RIKEN. Since the combination of medicines with appropriate diagnosis techniques is important for effective use of medicines, for example, RIKEN is expected to search biomarkers capable of detecting diseases before their onset or at an early stage in collaboration with each center by using techniques for genome-omics researches owned by RIKEN, and develop diagnosis methods by use thereof. Specifically, RIKEN promotes research and development in view of pharmaceutical application of diagnostic devices capable of simply detecting biomarkers found and transfers them to private businesses. In addition to those mentioned above, RIKEN shall be committed to making proposals on plans based on social and policy demands and promoting programs for collaborations and networks in a focused manner toward the realization of science and technology innovation.	