FY2013

BASIC RESEARCH PROGRAMS
(CREST, PRESTO)

Invitation for Application of Research Proposals
[Application Guidelines]

Department of Innovation Research
Japan Science and Technology Agency

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Chapter 1 Introduction

1.1 Strategic Basic Research Programs

1.1.1 Program Intent

The purpose of Strategic Basic Research Programs is to advance basic research aimed at achieving solutions for key issues facing Japan, and create the seeds of innovative technologies from new scientific knowledge that gives rise to scientific and technical innovation leading to social and economic change.

1.1.2 Program Overview

Based on the national government's science and technology policies, and social and economic needs, the Ministry of Education, Culture, Sports, Science and Technology establishes Strategic Objects for achieving solutions to issues the country should address, and JST, working within that framework, specifies Research Areas to pursue and a Research Supervisor (Program Officer) to lead them. The Research Supervisor pursues directed basic research aimed at creating the seeds of innovative technologies that will give rise to science and technology innovations that lead to the achievement of solutions in Strategic Objects.

The Program Directors consider and propose management policies and system reforms for a Strategic Basic Research Program. For "CREST" (Research projects pursued by research teams led by Research Directors) and "PRESTO" (Research projects pursued by individual researchers) within Strategic Basic Research Programs, JST specifies Research Areas and a Research Supervisor (Program Officer) based on prior evaluations by Program Directors.

The Research Supervisor oversees Research Areas as a "virtual research institute." More specifically, the Research Supervisor acts as the lab director, builds a time-limited system for conducting research by organizing a research project and assembling an optimal mix of researchers from industry, academia, and government, and, enlisting the cooperation of Research Area Advisors and others, oversees work in the Research Area to accomplish Strategic Objects. CREST Research Directors and PRESTO individual researchers, while receiving support as prescribed by Research Supervisors, actively build personal networks through dialogue with Research Area Advisors and others, connections with participating researchers, and relationships with others inside and outside the country, and apply these networks in advancing the research projects they have proposed to achieve innovations in science and technology.

1.2 Inviting Research Areas

As shown in the table below, CREST invites research proposals for the 15 Research Areas and PRESTO for 11 Research Areas.

○ Green Innovation

Research Areas	Type of the Research Area	Page	Strategic Objects	Page	Since
Creation of Innovative Core Technology for Manufacture and Use of Energy Carriers from Renewable Energy （Research Supervisor: Koichi Eguchi）	CREST - PRESTO Combined Research Area	69	Creation of core technologies for innovative energy carrier utilization aimed at the transport, storage, and use of renewable energy	124	FY2013
Innovative nano-electronics through interdisciplinary collaboration among material, device and system layers （Research Supervisor: Takayasu Sakurai Deputy Research Supervisor: Naoki Yokoyama)	CREST - PRESTO Combined Research Area	72	Creation of innovative core technologies by merging material technology, device technology, and nano-system optimization technology toward the realization of information devices with ultra-low power consumption and multiple functions	129	
Creation of Innovative Functional Materials with Advanced Properties by Hyper-nano-space Design （Research Supervisor: Toru Setoyama)	CREST	75	Creation of new functional materials by means of technology for controlling spaces and gaps in advanced materials in order to realize selective material storage, transport, chemical separation, and conversion, etc.	134	
Hyper-nano-space Design toward innovative functionality （Research Supervisor: Kazuyuki Kuroda）	PRESTO	77			
Creation of fundamental theory and technology to establish a cooperative distributed energy management system and integration of technologies across broad disciplines toward social application[1] (Research Supervisor: Masayuki Fujita)	CREST	79	Creation of theory, mathematical model, and fundamental technology to establish a cooperative distributed energy management system, which enables the optimization of demand and supply for various energies including renewable energy	139	FY2012
Establishment of Molecular Technology towards the Creation of	CREST	82	Establishment of molecular technology, which is the free control	145	

[1] In the research area "Creation of fundamental theory and technology to establish a cooperative distributed energy management system and integration of technologies across broad disciplines toward social application" (CREST), we invite following research proposals; research period is for one and a half years, and total research budget is maximum 90 million yen. For details, please see "Research Supervisor's Policy on Call for Application, Selection, and Management of the Research Area".

New Functions (Research Supervisor: Hisashi Yamamoto)			of molecules to bring innovation to environmental and energy materials, electronic materials, and health and medical materials		
Molecular technology and creation of new functions (Research Supervisor: Takashi Kato)	PRESTO	84			
Phase Interface Science for Highly Efficient Energy Utilization[2] (Research Supervisor: Nobuhide Kasagi)	CREST	88	To realize breakthroughs in phase-interface phenomena and create basic technologies for high-functionality interface that will result in dramatic advancements in highly-efficient energy utilization	149	FY2011
Phase Interfaces for Highly Efficient Energy Utilization (Research Supervisor: Nobuhide Kasagi)	PRESTO	90			
Creation of essential technologies to utilize carbon dioxide as a resource through the enhancement of plant productivity and the exploitation of plant products (Research Supervisor: Akira Isogai)	CREST - PRESTO Combined Research Area	93	Creation of basic technologies for utilizing plant photosynthetic functions and biomass that will enable the actualization of efficient carbon dioxide utilization	155	
Establishment of core technology for the preservation and regeneration of marine biodiversity and ecosystems (Research Supervisor: Isao Koike)	CREST	95	Creation of basic technologies for understanding marine ecology highly efficiently and forecasting marine life changes to conserve and regenerate the marine biodiversity required for sustainable usage of ocean resources	158	

2 In the research area "Phase Interface Science for Highly Efficient Energy Utilization" (CREST), please select either "Science Approach" or "Engineering Science Approach" when you apply. For details, please see "Research Supervisor's Policy on Call for Application, Selection, and Management of the Research Area".

○ Life Innovation

Research Areas	Type of the Research Area	Page	Strategic Objects	Page	Since
Creation of Innovative Technology for Medical Applications Based on the Global Analyses and Regulation of Disease-Related Metabolites (Research Supervisor: Takao Shimizu)	CREST	98	Creation of core technologies for early-stage drug discovery through the investigation of disease-specific profiles of biomolecules	163	FY2013
Creation of Innovative Technology for Medical Applications Based on the Global Analyses and Regulation of Disease-Related Metabolites (Research Supervisor: Yoshiya Oda)	PRESTO	101			
Innovation for Ideal Medical Treatment Based on the Understanding of Maintenance, Change and Breakdown Mechanisms of Homeostasis among Interacting Organ Systems (Research Supervisor: Ryozo Nagai)	CREST	104	Integrated clarification of the maintenance and change mechanisms of dynamic homeostasis in the body and creation of technology to understand and regulate complex dynamic homeostasis to achieve preventive medicine, appropriate diagnosis and treatment	169	FY2012
Elucidation and regulation in the dynamic maintenance and transfiguration of homeostasis in living body (Research Supervisor: Masato Kasuga)	PRESTO	106			
Structural life science and advanced core technologies for innovative life science research (Research Supervisor: Keiji Tanaka)	CREST	108	Creation of new technologies for breakthrough in understanding and predicting biological activities and intermolecular interactions by means of "Novel Structural Life Science" that contributes to new medical treatment and prevention of various diseases, food safety enhancement and environmental improvement	173	
Structural life science and advanced core technologies for innovative life science research (Research Supervisor: Soichi Wakatsuki)	PRESTO	110			
Development of Fundamental Technologies for Diagnosis and Therapy	CREST	113	Creation of the basic technologies for disease analysis and elucidation of stem cell differentiation	177	FY2011

Based upon Epigenome Analysis (Research Supervisor: Masayuki Yamamoto) Deputy Research Supervisor: Toshikazu Ushijima)			mechanisms by using epigenomic comparison toward the realization of treatments and regenerative medicine used to prevent, diagnose, and treat diseases		
Creation of Fundamental Technologies for Understanding and Control of Biosystem Dynamics (Research Supervisor: Tadashi Yamamoto)	CREST	115	Creation of the technology systems to have absolute control of cells and cell populations by reproducing cell kinetics in silico/in vitro in order to achieve an integrated understanding of life phenomena and realize safe and highly effective treatments among other benefits	180	
Design and Control of Cellular Functions (Research Supervisor: Hiroki Ueda)	PRESTO	117			

○ ICT

Research Areas	Type of the Research Area	Page	Strategic Objects	Page	Since
Advanced Application Technologies to Boost Big Data Utilization for Multiple-Field Scientific Discovery and Social Problem Solving (Research Supervisor: Yuzuru Tanaka)	CREST	119	Creation, advancement, and systematization of innovative information technologies and their underlying mathematical methodologies for obtaining new knowledge and insight from use of big data across different fields	183	FY2013
Advanced Core Technologies for Big Data Integration (Research Supervisor: Masaru Kitsuregawa)	CREST - PRESTO Combined Research Area	121			

The classification of Research Areas and Strategic Objects into three categories of “Green Innovation”, “Life Innovation” and “ICT” is defined by JST for convenience. It is not trying to reject inter-disciplinary proposals nor proposals belonging to different categories. Please refer to Chapter4. “Outline of the Research Area” and “Research Supervisor’s Policy on Call for Application, Selection and Management of the Research Area”

1.3 Solicitation and Selection Schedule

1.3.1 Schedule for the acceptance and selection of research proposals

The FY2013 schedule for the acceptance and selection of research proposals is shown in the following table. **Please note that the application acceptance deadlines for CREST and PRESTO are different.**

Application of proposal is implemented via e-Rad system. Just before the deadline, it might happen that the acceptance of the research proposals is not completed due to the congestion of the e-Rad system. Please give yourself plenty of time to complete submission of proposal.

	CREST	PRESTO
Research Proposal acceptance begins	April 18 (Thu), 2013	
Application deadline (Deadline for submitting applications through the e-Rad System)	**June 13 (Thu) at 12:00 noon, Japan time (No delays accepted)**	**June 11 (Tue) at 12:00 noon, Japan time (No delays accepted)**
Document screening period	Late June – Late July	
Notification of document screening results	Late July – Early August	
Interview period	Late July – Late August	
Notification / announcement of selected Research Projects	Late September	
Research begins	After October	

* The underlined dates are final, but all others are expected dates. They are subject to change.

* As soon as it is determined, the interview selection schedule will be announced on the website shown below:

http://www.senryaku.jst.go.jp/teian-en.html

1.3.2 Schedule for Briefings of Solicitation

Briefings of Solicitation for each research area are planned as following dates. (NOTE: only in Japanese.) Briefing of the whole Strategic Basic Research Programs will not be held.

Research Area	Page	Date	Place
Innovation for Ideal Medical Treatment Based on the Understanding of Maintenance, Change and Breakdown Mechanisms of Homeostasis among Interacting Organ Systems（CREST）	104, 106	April 22, (Mon.) 13：00～14：30	JST Tokyo Headquarters Annex 1st Floor Hall

Elucidation and regulation in the dynamic maintenance and transfiguration of homeostasis in living body (PRESTO)			
Creation of Innovative Core Technology for Manufacture and Use of Energy Carriers from Renewable Energy（CREST・PRESTO）	69	April 23, (Tue.) 14：00～ 15：00	JST Tokyo Headquarters Annex, 1st Floor Hall
Creation of Innovative Technology for Medical Applications Based on the Global Analyses and Regulation of Disease-Related Metabolites（CREST） Creation of Innovative Technology for Medical Applications Based on the Global Analyses and Regulation of Disease-Related Metabolites（PRESTO）	98, 101	April 23, (Tue.) 13：00～ 15：00	JST Tokyo Headquarters, Basement 1st Floor Conference Room
Innovative nano-electronics through interdisciplinary collaboration among material, device and system layers（CREST・PRESTO）	72	April 24, (Wed.) 11：00～ 12：00	JST Tokyo Headquarters Annex, 1st Floor Hall
Creation of fundamental theory and technology to establish a cooperative distributed energy management system and integration of technologies across broad disciplines toward social application (CREST)	79	April 24, (Wed.) 14：00～ 15：00	JST Tokyo Headquarters Annex, 1st Floor Hall
Advanced Application Technologies to Boost Big Data Utilization for Multiple-Field Scientific Discovery and Social Problem Solving（CREST） Advanced Core Technologies for Big Data Integration（CREST・PRESTO）	119, 121	April 25, (Thu.) 13：00～ 14：00	JST Tokyo Headquarters Annex, 1st Floor Hall
Establishment of Molecular Technology towards the Creation of New Functions (CREST) Molecular technology and creation of new functions (PRESTO)	82, 84	April 26, (Fri.) 13：00～ 14：30	JST Tokyo Headquarters Annex, 1st Floor Hall

Creation of Innovative Functional Materials with Advanced Properties by Hyper-nano-space Design （CREST） Hyper-nano-space Design toward innovative functionality （PRESTO）	75, 77	April 26, (Fri.) 15：00～ 16：30	JST Tokyo Headquarters Annex, 1st Floor Hall
Creation of Innovative Technology for Medical Applications Based on the Global Analyses and Regulation of Disease-Related Metabolites （CREST） Creation of Innovative Technology for Medical Applications Based on the Global Analyses and Regulation of Disease-Related Metabolites （PRESTO）	98, 101	April 26, (Fri.) 13：30～ 15：00	Campus Plaza Kyoto, 4th Floor 4th Lecture Room

JST Tokyo Headquarters Annex K's Gobancho：Gobancho 7,Chiyoda-ku,Tokyo

JST Tokyo Headquarters：Science Plaza ： Yonbancho 5-3, Chiyoda-ku,Tokyo

Campus Plaza Kyoto：Nishino-Toin-dori Shiokoji Sagaru, Shimogyo-ku, Kyoto

(NOTE)

Related information, handout and so on of Briefings of Solicitation is available on the Website for Research Proposal Solicitation

Website for Research Proposal Solicitation (only in Japanese);

http://www.senryaku.jst.go.jp/teian.html

Briefings of Solicitation of the following Research Areas have been already finished. The information of the briefings are available from the website below;

http://www.senryaku.jst.go.jp/teian.html

“Creation of Fundamental Technologies for Understanding and Control of Biosystem Dynamics” Research Area (page.115), “Design and Control of Cellular Functions” Research Area(page.117)

(Joint briefing of CREST and PRESTO)

Date：March 20 (Wed.)

Place：Kyoto

“Creation of essential technologies to utilize carbon dioxide as a resource through the enhancement of plant productivity and the exploitation of plant products” Research Area (page. 93)

(Joint briefing of CREST and PRESTO)

Date：April 6 (Sat.)

Place：Tokyo

"Structural life science and advanced core technologies for innovative life science research" Research Area(page. 108 and 110)

(Joint briefing of CREST and PRESTO)

Date：April 8(Mon.), 12 (Fri.))

Place : Tokyo and Osaka

1.4 **Submission of Research Proposal**

Please see the following part of this guideline regarding how to submit research proposal and items to be considered.

- The items to be included in the research proposal of CREST:
  "Chapter 2 CREST 2.4　Research Proposal (Form) Completion Requirements"
- Regarding the items to be included in the research proposal of PRESTO:
  "Chapter 3 PRESTO 3.4　Research Proposal (Form) Completion Requirements"
- Regarding the way to apply the Research Proposal：
  "Chapter 8 Submitting Applications using the e-Rad System"
- The items to be considered in application:
  "Chapter 6　Key Points in Submitting Proposals" and "Chapter 7 Duplicated Applications for JST Programs"

1.5 **Gender Equality**

JST promotes gender equality!

JST is promoting gender equality in science and technology.

The Council for Science and Technology Policy put forward the slogan "Promoting the activities of female researchers" in the 3rd Basic Program for Science and Technology. There is consideration that the future of technology in Japan relies on power of those who play an active part, and that an environment must be established in which diverse and versatile individuals can demonstrate their ambition and potential. The 4th Basic Program for Science and Technology states, "The expected target ratio of the overall selections of female researchers for programs in natural sciences should be 25%."

As one of the action policies in promoting our programs, JST puts forward a slogan that “JST will set a plan to promote gender equality, and take the initiative in cultivating an environment in which a variety of talented researchers such as female researchers can demonstrate their capability.”

In selecting new subjects, we are going to implement the process of screening based on the viewpoint of gender equality. Those proposals where men and women are participating and playing an active part together will be strongly appreciated.

We are looking forward to active applications from both male and female researchers.

Michiharu NAKAMURA, D.Sc.
President
Japan Science and Technology Agency

All female researchers, let‘s take this opportunity to apply for a further leap forward!

The percentage of female researchers remains as little as 13.8% (As of 2010, from a 2011 report on Survey of Research and Development by Ministry of Internal Affairs and Communications). The number is rising but it is still lower than expected in the international community. Some of the reasons behind this low number include the difficulties in continuing research due to child bearing, child rearing and nursing care, inadequate systems for the employment of female researchers, and the very limited number of female students who major in science.

The government is dealing with these issues. At the same time, I believe that change in the way of thinking of female researchers and the whole society is also necessary. I would like these capable individuals to continue the challenge towards a further step-up little by little and avoid giving up, or accepting the idea that ”I am okay with where I am now”.

JST promotes research programs by inviting research proposals from researchers. So, I would like female researchers to take the first step for leap forward by applying research proposals first. JST considers that increase of research proposals leads to increase of adaptation and then it promotes to expand research opportunities for whole female researchers.

In response to this opportunity, I hope that female researchers will develop their ideas through participating in JST programs and go on to bravely become attractive role models for their juniors.

Kashiko KODATE
Program Director
Office for a Gender Equal Society,
Japan Science and Technology Agency
(Professor emeritus at Japan Women’s University)

- JST helps female researchers continue to be both a researcher and a mother at the major life events including child bearing, child rearing, nursing care and the like. For details, see the following websites.

JST Gender Equal Society website:
http://www.jst.go.jp/gender/ (in Japanese)

Female researchers actively working on CREST
http://www.jst.go.jp/kisoken/crest/nadeshiko/index.html (in Japanese)

PRESTO ’Nadeshiko’ campaign
http://www.jst.go.jp/kisoken/presto/nadeshiko/index.html (in Japanese)

1.6 Dialogue with Citizens on Science and Technology

The basic policy on promoting a science and technology dialogue with citizens, announced on June 19, 2010, describes as science and technology dialogues with citizens conversations in which scientists explain their research activities and results to society and its citizens in easily comprehensible terms – in sincere two-way communications that encourage hope for the future. Research projects receiving public research funds of 30 million yen or more per year are expected to actively engage in science and technology dialogues with citizens. For more details, please refer to”2.3.4 Responsibilities of Research Directors” and the following URL；
http://www8.cao.go.jp/cstp/output/20100619taiwa.pdf

1.7 Government approval of the budget

Please note that this call for proposals is on the condition that the government budget of FY2013 is passed.

1.8 Open Access

JST announced the policy regarding Open Access in April 2013. Research Results (papers) from CREST or PRESTO are endorsed to open to the public via institutional repositories and so on. Please find the details from the following website;

http://www.jst.go.jp/pr/intro/johokokai.html

Chapter 2　CREST Program

2.1　CREST

2.1.1　CREST Overview

Key points and characteristics of CREST are discussed below.

a. CREST promotes directed basic research that is unique and among the most advanced of its kind in the world, in order to accomplish strategic objects designated by the national government. CREST supports research undertaken by research teams aiming to produce outstanding results that will contribute greatly to future science and technology innovation.

b. Research Area is overseen by the Research Supervisor, who manages Research Directors at industrial, academic, or government institutions. The Research Supervisor manages Research Areas as a virtual research institute.

The Research Supervisor, in his/her role as director of a virtual research institute, enlists the cooperation of Research Area Advisors and others in managing Research Areas through the following activities.

- Specification of a management direction for individual Research Area
- Research projects selection
- Refinement and approval of research plans (including research costs and assembly of the research team)
- Participating in meetings at which Research Directors report on their research progress and have their results discussed, visiting labs where research is being performed, and taking other opportunities as well to communicate with Research Directors and provide them with advice and guidance on their efforts.
- Research project evaluation
- Other necessary activities

c. A Research Director can bring multiple researchers together in a team optimal for pursuing the Research Director's proposed research initiative. A Research Director advances research that will contribute to the overall purposes of the Research Area, while bearing full responsibility for the research project he/she is leading.

2.1.2　Program Scheme of CREST

(1) Research Budgets

The budget for one research team basically ranges from 150 million yen to 500 million yen (for entire research periods up to five and a half years).Please refer to “Chapter 4 **O**utline of the Research Area and Research Supervisor’s Policy on Call for Application, Selection and Management of the Research Area” for details. In addition, JST, under contract research agreements, pays research institutions funds equal to 30% of the research budget (direct cost) to cover overhead (indirect cost).

- Proposed research budgets are examined as part of the selection process. Actual research budgets are determined through examination and approval of research project planning. For more details, please refer to “2.3 After Selection: Proceeding with Research Work”.

(2) Research Period

Research periods may last up to five and a half years (but may extend to the end of the sixth year).

- Actual research periods depend on research project plans. For more details, please refer to “2.3 After Selection: Proceeding with Research Work”.

(3) Research Team Organization

A Research Director can bring together multiple researchers into an optimum research team.

a. The person proposing a research project, a research project applicant, can organize a research team – Research Director's Group – consisting of only people from his/her research lab. Alternatively, when pursuing a research initiative requires it, a research team including a group ("joint research group") of researchers or other personnel from unrelated research labs or research institutions may also be organized.

b. Among researchers comprising a research team, those representing a "joint research group" are referred to as "Main Research Collaborator."

c. When necessary for the pursuit of research, researcher staff, research assistants, and other personnel can be employed within the research budget and allowed to participate as members of the research team.

- For more details on research team organization requirements, please refer to "2.2.4 Application Requirements".

2.1.3 Program Flow of CREST

(1) Solicitation and Selection of Proposals

JST solicits research proposals for individual Research Areas specified among the Strategic Objects designated by the national government. Selection of proposals is made by the Research Supervisor, with the cooperation of Research Area Advisors and others, for individual Research Areas.

- For more details, please refer to "2.2 Solicitation and Selection of Proposals".

(2) Research Plan Preparation

Once a proposal has been selected, the Research Director prepares an overall research plan covering the entire period of the research project. The Research Director also prepares annual research plans for each year of the project. Research plans cover budgets and research team composition.

- For more details, please refer to "2.3.1 Research Plan Preparation".

(3) Agreements

Once a research proposal has been accepted, JST will enter into contract research agreements with the research institutions with which the Research Director and Main Research Collaborators are associated.

- For more details, please refer to "2.3.2 Agreements".

(4) Research Work

Research work is to be performed over a period of five and a half years (but may extend to the end of the sixth year).

(5) Evaluation

The Research Supervisor will familiarize himself/herself with the status and results of individual research projects and, with the cooperation of Research Area Advisors and others, produce interim and post-completion evaluations. In addition to research project evaluations, Research Area evaluations are performed to examine Research Areas and the Research Supervisor. Research Area evaluations are performed on an interim and post-completion basis.

- For more details, please refer to "2.3.6 Research Project Evaluations" and "2.3.7 Research Area Evaluations".

2.2 Solicitation and Selection of Proposals

2.2.1 Eligible Research Proposals

(1) Research proposals are solicited for the 15 Research Areas (Research Areas introduced in fiscal years 2011, 2012, and 2013) mentioned in “Chapter 1 Introduction 1.2 Research Areas for which Research Proposals are Solicited.”.

(2) Carefully read the “Research Area Outline” for each of the Research Areas mentioned in “Chapter 4 Research Areas for which Proposals will be Solicited 4.1 CREST” and the “Research Supervisor’s Policy on Calls for Proposals, Selection and Management of the Research Area” before proposing research appropriate for one of the Research Areas.

2.2.2 Solicitation Period

April 18 to June 13 (12:00 noon) 2013 (No exceptions).

For information on schedules for briefings, calls for proposals, etc., please refer to "1.3 Solicitation and Selection Schedule".

2.2.3 Numbers of Research Projects

Three to eight research projects shall be selected for each Research Area. (The number for any particular Research Area will vary depending on research intent, conditions with regard to research proposals, and budget limitations.)

2.2.4 Proposal Submission Requirements

Proposal submission requirements are discussed below.

When submitting a proposal, please do so based on an understanding of the points under (1) through (3) below, and discussed in “Chapter 6 Key Points in Submitting Proposals” and “Chapter 7 Duplicated Applications for JST Programs”.

(1) Requirements for Research Project Applicants

a. Research project applicants must be affiliated with a domestic Japanese research institution, where they will organize and pursue the proposed research (The nationalities of research project applicants are not considered.)

➢ The following types of people may also submit research project proposals.

- Researchers who have foreign citizenship, but are associated with a domestic Japanese research institution.
- Researchers who are not currently affiliated with a research institution, or are affiliated with an overseas research institution, and, if selected as a Research Director, would be able to organize and pursue research as a researcher affiliated with a domestic Japanese research institution. (Nationality will not be considered.)

b. Researchers who are able to bear overall responsibility for a research project as the party responsible for the research team throughout the entirety of the research period.

➢ For more details, please refer to “2.3.4 Responsibilities of Research Directors”.

(2) Requirements for Organizing a Research Project

The following requirements must be met. Please refer to "2.2.7. Selection Perspective item d".

a. A research team is the optimal organizational approach for pursuing the research initiatives of the research project applicant.

b. When a joint research group is organized to work with the research team, the joint research group is essential for pursuing research initiatives and can contribute greatly to achievement of the research objectives.

c. When overseas research institutions will participate in a research project as joint research groups (Researchers affiliated with overseas research institutions will participate as Main Research Collaborator), they are essential for pursuing research initiatives and pursuing the research project would be impossible without the subject overseas research institutions. It should be noted that participation of such institutions requires the approval of the Research Supervisor.

- ➢ When it is desired that one or more overseas research institutions be included in a research team, please note on the research proposal (CREST – Form 12) the reasons why the participation of research collaborator affiliated with overseas research institutions is required.

d. Researchers who are presently PRESTO researchers cannot function as Main Research Collaborator (Except in cases in which PRESTO research work will be concluded in FY2013.)

(3) Research Institutions Requirements

a. The research institutions (where the proposed research project will be pursued) with which the research project applicant and Main Research Collaboratorare affiliated must meet the required conditions and be able to enter into a contract research agreement with JST.

- ➢ For more details, please refer to "2.3.5 Research Institution Requirements and Responsibilities".

b. When a research institution is an overseas research institution, it must meet the following additional conditions.

・ The overseas research institution must be able to share intellectual property with JST. (Article 19 (Japanese version of the Bayh-Dole Act) of the Industrial Technology Enhancement Act is not applicable to overseas research institutions.)

・ The overseas research institution shall not receive payments for overhead costs (indirect cost) in excess of 30% of the research budget.

・ In principle, the overseas research institution can enter into agreements in forms specified by JST.

2.2.5 Conflicts of Interest involving Research Project Applicants and the Research Supervisor

Research project applicants shall be excluded from selection consideration when involved in a relationship involving a Research Supervisor, as described in a. through d. below. When it is unclear whether a condition applies, an inquiry should be made to rp-info@jst.go.jp before submitting a research project proposal by preparing Inquiry Form.

Inquiry Form:
http://senryaku.jst.go.jp/teian.html

a. The research project applicant is a relative of the Research Supervisor.

b. The research project applicant and the Research Supervisor are both affiliated with the same smallest organizational unit (e.g. same research lab) of a university, national or other national government-funded research and experiment institution. Or, the research project applicant and the Research Supervisor are affiliated with the same company.

c. The research project applicant and the Research Supervisor are presently working in close cooperation

on the same joint research project. Or, have done so within the past five years.
(For example, the research project applicant and the Research Supervisor are working together on the same research project, are performing different parts of the same research project, or are co-authors of a research paper.)

d. The research project applicant and the Research Supervisor were in a close teacher-student relationship for a total of more than 10 years (not necessarily continuous), or were in a direct employer-employee relationship. "Close teacher-student relationship" means cases in which the research project applicant and the Research Supervisor were affiliated with the same research lab, and cases in which the Research Supervisor, though affiliated with a different organization, essentially functioned as a research advisor for the research project applicant.

- For Research Areas in which Deputy Research Supervisors have been established, the same provisions shall apply.
- For inquiries submitted by May 10, responses as to whether any of the relationship conditions described above have been violated shall be provided by the proposal deadline. For inquiries submitted after May 10, such responses may not be provided by the proposal deadline. Acceptance of research project proposals may be canceled if it is determined following the proposal deadline that any of the relationship conditions described above have been violated.

- Please make use of the (CREST- Attachment) Pre-Submission Check Sheet "Relationships with the Research Supervisor.

2.2.6 Selection Method

For schedule information, please refer to " 1.3 Solicitation and Selection Schedule".

(1) Selection Process

For each Research Area, the Research Supervisor, enlisting the cooperation of Research Area Advisors and others, shall select research proposals in two stages– one based on documentation and the other based on interviews. When necessary, other examinations, etc. may also be conducted. In addition, the cooperation of external evaluators may also be enlisted. JST shall select Research Directors and research projects based on this process.

The names of Research Area Advisors shall be posted on the research proposal solicitation homepage as soon as they become available (Japanese only).

http://www.senryaku.jst.go.jp/teian.html

(2) Persons Involved in the Selection Process

To ensure fair and transparent evaluations, the following interested parties shall be excluded from the selection process, based on relationships with research project applicants, in accordance with JST rules.

a. Relatives of research project applicants.

b. Persons who were in the same department or research lab as a research project applicant at a university, national and other national government-funded research and experiment institution, or who were affiliated with the same company.

c. Persons who worked in close cooperation on a joint research project with a research project applicant. (For example, a person who worked on a joint research project, co-authored a research paper, worked toward the same objectives as a member of the same research team, performed different parts of the same research project, or were otherwise essentially affiliated with the same research group as a research project applicant.)

d. Persons who were in a close teacher-student relationship, or were in a direct employer-employee relationship, with a research project applicant.

e. Persons in relationships of direct competition with a research project of a research project applicant.

f. Persons in other relationships judged by JST to represent conflicts of interest.

(3) Interview-Based Selections and Notification of Selection Results

a. Research project applicants who have been selected for participation in the interview phase of the process based on documentation-based selection results, shall be notified of their selection in writing. They will also be provided with an overview of the interview process, schedule information, and instructions regarding matters like the submission of additional information. They may be required to submit the proposal, research plan and so on of other research grants. In case Research Director or Main Research Collaborator belongs to profit-making-institution etc., financial statements may be required to submit.

Information on the schedule for the interview-based selection phase shall be posted on the research proposal solicitation homepage (http://www.senryaku.jst.go.jp/teian.html) as soon as it becomes available.

b. In the interview, the research project applicant shall be asked to explain the proposed research initiative. It should be noted that interviews shall basically be conducted in Japanese, but that English may be used when conducting the interview in Japanese is impractical.

c. Research project applicants who are not selected in either the document-based or interview-based selection phases shall be notified in writing.

d. Research project applicants who are selected shall be notified of their selection in writing and provided with information on procedures for commencing research.

2.2.7 Selection Perspective

(1) Selection Standards (Preliminary Evaluation Standards)

Common selection standards for all CREST Research Areas are described below. (All standards described in a.～d. must be met.)

a. Contributes to the achievement of Strategic Object.

b. Consistent with the Research Area intent (Refer to Addendum 1. Addendum 2.)

c. Basic research that is unique, highly appreciated internationally, and expected to produce outstanding results (Refer to Addendum 3.) that contribute greatly to science and technology innovation.

d. Meets all of the following conditions.

- The research project applicant has produced research results for accomplishing research objectives.
- Promising preliminary results have been obtained for pursuing the research initiative.
- An optimal research organization is in place.

The research project applicant will exercise strong leadership and bear responsibility for the entire research team, and, if there will be Main Research Collaborators, they are essential for pursuing the research project applicant's research initiatives, and a collaboration framework sufficient for enabling significant contributions toward the achievement of research objectives will be constructed.

- Research budget planning necessary and sufficient for pursuing the research project applicant's research initiatives has been performed.

- The research institutions with which the research project applicant and Main Research Collaborators are affiliated have R&D capabilities and other technical foundations in the subject research field.

《Addendums》

1. Regarding item b. “Research Area intent,” please refer to “Chapter 4 Research Areas for which Proposals will be Solicited 4.1 CREST” discussions of “Research Area Outline” and “Research Supervisor’s Policy on Calls for Proposals, Selection and Management of the Research Area” for individual Research Areas. Contained therein are discussions of selection perspectives and policies, management directions, etc. for individual Research Areas.
2. Whether the research project structure fits with the desired research project structure to optimize the entire research area under the policies and directions discussed above is another selection perspective.
3. The "results" sought for Strategic Basic Research Programs are new technologies.
   "New technologies" are science and technology R&D results that are viewed as significant for the nation's economy, but have not yet entered commercialization development (have not undergone commercial-scale testing used in commercial production).

➢ "New technologies" and "commercialization development" are terms used (as rendered in Japanese) in the text of the Act on the Japan Science and Technology Agency, Independent Administrative Agency.

(2) Whether research budgets are characterized by "unreasonable duplication" or "excessive concentration" is a selection criterion. For more details, please refer to "6.2 Unreasonable Duplication and Excessive Concentration”.

2.2.8 Specific Project Investigation

(1) When a research project application can be supported with supplemental research data that can be obtained for little financial cost and in a short amount of time, and it is expected that the application thus supported would be appropriate for regular evaluation in the following or later fiscal years, the Research Supervisor may request the research project applicant to undertake a Specific Project Investigation separate and apart from the regular selection process.

(2) Specific Project Investigation can be performed under the condition that an application will be resubmitted for the subject Research Area in the following or later fiscal years. The resubmitted application will then be treated like other research project applications, and shown no favoritism.

(3) Specific Project Investigation cannot be applied for directly.

2.2.9 Research Proposal Forms and Completion Requirements

Please refer to "2.4 Research Proposal (Form) Completion Requirements".

○ Some research areas require to use the original proposal forms. Please use the proposal form of the research area which you are planning to apply.

○ Some research areas settle distinct requirement for proposal (research period and research budgets). Please refer to “Chapter.4 “Outline of the Research Area” and “Research Supervisor’s Policy on Call for

Application, Selection and Management of the Research Area”for detail.

2.3 After Selection: Proceeding with Research Work

2.3.1 Preparing a Research Plan

a. Once selected, the Research Director will prepare an overall research plan covering the entire research project period (up to five and a half years). The Research Director will also prepare annual research plans. Research plans include information on the research budget and research team structure.
Proposed research budgets will undergo an assessment in the selection process.

b. Research plans (overall and annual plans) become official once they are checked and approved by the Research Supervisor. The Research Supervisor will offer advice and coordination assistance on the research plan, and provide instructions when necessary, based on information the Research Supervisor gains through, for example, the project selection process, discussions with Research Directors, regular progress updates, and the results of research evaluations.

c. The Research Supervisor, in approving research project plans to achieve objectives including the accomplishment of the overall objectives of a Research Area, may merge or link research projects, or take other such coordinative actions.

➢ Research organizations and budgets set forth in research plans may be revised during the research project period in response to overall Strategic Basic Research Program budget conditions, Research Area management actions taken by the Research Supervisor, or factors like results of research evaluations.

2.3.2 Agreements

a. Once a research project is selected, JST, in principle, will enter into a contract research agreement with the research institutions with which the Research Director and Main Research Collaborator are affiliated.

b. If it is not possible to enter into contract research agreements with these research institutions, not possible to put in place the management and audit systems required in connection with the use of public funds, or the subject research institutions are conspicuously financially unstable, it may be impossible to pursue research at the subject research institutions. For more details, please refer to "2.3.5 Research Institution Requirements and Responsibilities”.

c. Patents and other intellectual property rights resulting from research shall, in accordance with contract research agreement terms, reside with research institutions under the condition that the research institutions abide by the items provided in Article 19 (Japanese version of the Bayh-Dole Act) of the Industrial Technology Enhancement Act. However this rule does not apply to foreign research institutes.

2.3.3 Research Costs

Research costs shall be covered as contract research fees in payments by JST to research institutions. In addition to amounts covering the "direct cost" discussed in (1) below, JST shall also pay to research institutions an amount equal to 30% of direct cost as the "overhead cost” (indirect cost) discussed in (2).

(1) Research Costs (Direct Cost)

Research costs (direct cost) means costs that are directly related to and required for the pursuit of the subject CREST research. Research costs can include:

a. Goods:

Costs for the purchase of new equipment, supplies, etc. (*1)

b. Travel:

Expenses for travel by the Research Director or research team members for purposes necessary for and directly related to the accomplishment of the subject CREST research objectives.

c. Personnel and Services:

Annual salaries, etc. (*1) for staff (research staff, technicians, etc. except for Research Director and Main Research Collaborator) whose work is directly related to and required for the accomplishment of the subject CREST research objectives; personnel expenses for non-permanent, hourly or other technicians, research assistants, etc. performing data management or other such tasks; personnel expenses for research assistants (*2); and honorariums, etc. for speakers, etc. (Companies and other organizations may differ in their handling of these expenses. Please confirm details for any particular situation by referring to the contract research agreement explanations provided in the following URL:
http://www.jst.go.jp/kisoken/contract/top2.html)

d. Other:

In addition to the above, costs required for the accomplishment of the subject CREST research objectives, costs related to the presentation of research results (research paper submission fees, printing costs, etc.), equipment lease expenses, transportation costs, etc.

- The following costs are not treated as research costs (direct cost).
  - Costs for items not consistent with the subject CREST research objectives.
  - Costs that are considered to be more appropriately handled as overhead cost（indirect cost).
- When it is unclear whether a particular expense is appropriately considered a research cost (direct cost), ask JST for assistance.
- For certain items, JST has created rules and guidelines from sources like the contract research agreement, administration manuals, and a common governmental expense categorization table, and asks that these rules and guidelines be applied appropriately. Universities and other organizations (including public research institutions operated by the national government and independent administrative agencies, and public-service corporations and other organizations recognized by JST) and companies (mainly research institutions operated by private companies and other non-university organizations) may differ in their handling of administrative matters. For more details, please refer to the following URLs (only in Japanese).

http://www.jst.go.jp/kisoken/contract/ top2.html

*1 In hiring research staff, please give consideration to supporting the career paths of people who have recently completed their doctoral programs. For more details, please refer to “2.3.4 Responsibilities of Research Directors” and “2.3.9 Other Considerations”.

*2 Considerations in Hiring Research Assistants (RAs)

- ■ Focus on people in the latter stages of doctoral programs.
- ■ It is recommended that annual compensation approximate 2 million yen per year, or 170,000 yen per month, so please estimate research budgets based on these figures.
- ■ Judgments regarding the specifics of payment amounts, payment timing, etc. will be left to research institutions. There are no requirements concerning the payment of amounts either above or below the levels mentioned above.

■ It is assumed that employment as an RA is not considered an impediment under either the system through which the RA receives scholarship funds or for the research institution with which he/she is affiliated. JST imposes no limits on the receipt of multiple payments by RAs.

■ Please refer to the guidelines on RAs in “2.3.9 Other Considerations”.

(2) Carryover

In principle, research activities are to be pursued in accordance with annual research plans. However, in consideration of the occasional difficulty of using the entirety of a particular year's research budget and the waste and inappropriate accounting practices that can emerge from unreasonable efforts to use the entirety of a particular year's research budget, JST has adopted a simple carryover system that requires no troublesome application and approval procedures for carrying over to the following year budgeted funds that were not used because progress in implementing the research plan did not warrant them. (The carryover system is for universities and other organizations that have entered into multi-year agreements.)

2.3.4 Responsibilities of Research Directors

(1) Research Directors and Main Research Collaborator are responsible for fully recognizing that JST research budgets are funded by precious tax revenues collected from citizens, and for fairly and efficiently executing budgeted expenditures.

(2) Once a proposed research project is selected, the Research Director and Main Research Collaborator shall affirm that they will fulfill the following requirements, presented to them via JST briefings and other means, and submit to JST a written document evidencing this affirmation.

a. Comply with application and other requirements.

b. Acknowledge that JST research budgets are funded with tax revenues collected from citizens, and pledge not to use these funds for activities, applications, etc. that are improper for the pursuit of research.

c. To prevent research staff and others from engaging in activities (fabrication, manipulation, plagiarism, etc. of research papers) that are improper for the pursuit of research, require research staff and others to study JST-designated research ethics education materials (online materials) and pledge to achieve a common understanding that this study is required.

It should be noted that failure to fulfill the research ethics education requirement in c. above can result in the suspension of budgets related to the research staff and others who have not completed study of the research ethics materials, until it has been confirmed that this study has been completed.

(Note) The submission of written confirmation that this item has been fulfilled and the requirement that research ethics materials be studied apply to research projects selected in 2013 and later fiscal years.

(3)Researchers who participate in the relevant programs are required to complete the research morality course (online course) which JST specifies in order to prevent **acts** of academic dishonesty (forgery, manipulation, misuse and so on of scientific results).

(4) Pursuing and Managing Research

a. At a minimum, entire research teams shall bear responsibility for establishing and implementing research plans.

b. Research teams shall also be responsible for submitting research reports and other required documentation to JST (including the Research Supervisor) and taking steps required for research evaluations. Research teams shall also be responsible for providing the progress and other reports the Research Supervisor may request from time to time.

(5) Research Directors together with research institutions shall appropriately manage (expenditure planning, monitoring, etc.) overall research budgets for research teams. Main Research Collaborator together with research institutions shall appropriately manage (expenditure planning, monitoring, etc.) research budgets for his/her own research team.

(6) Research Directors and Main Research Collaborator are asked to be mindful of research and working environments and conditions for their own group's research participants, and especially research staff and others whose employment is being funded by CREST research funds.

(7) It is recommended that Research Directors and Main Research Collaborator actively support the development of varied domestic and international career paths for research staff who have recently completed doctoral programs and are being employed with research budget funds. In the research project selection interview, research project applicants will be asked about plans[1] for supporting the development of varied domestic and international career paths for research staff who have recently completed doctoral programs and will be employed with research budget funds. In addition, in interim and post-completion evaluations, questions will be asked regarding the status of career path assistance efforts and the post-completion career paths of the research staff who were the subject of career path assistance efforts. Responses to these questions may positively affect project evaluations.
※ Please refer to the details in “2.3.9 Other Considerations”.

(8) Handling of Research Results

a. Given that research results were obtained with national government funding, it is asked that research results be actively reported on both domestically and internationally, with due consideration for the acquisition of intellectual property rights.
b. When reporting on research results through research papers or other media, please indicate that the research results were obtained via the Strategic Basic Research Programs (CREST).
c. Research team members may be asked to participate in JST-sponsored domestic and international workshops and symposia, and to report on research results.
d. It is asked that active efforts be made to secure intellectual property rights. In principle, intellectual property rights are to be pursued, in accordance with contract research agreement terms, by the research institutions with which researchers are affiliated.

(9) Research Directors are asked to actively engage citizens in discussions of science and technology to promote citizen understanding and support of science and technology. Efforts to engage citizens in discussions of science and technology will be evaluated both interim and post-completion evaluations.

- Please refer to the guideline details in ”1.6 Dialogue with Citizens on Science and Technology”.

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[1] Some activities called for by these plans can be included among research efforts.

(10) Research Directors shall abide by research agreements entered into by JST and research institutions, and shall abide by JST's various rules.

(11) It should be noted that JST will provide research project names, names of researchers, research budget information, and other required information to the Cross-ministerial R&D Management System (e-Rad) and the Government Research and Development Database ("Chapter 6 Key Point in Submitting Proposals"). Research Directors and others, therefore, may be asked to provide various types of information in that connection.

(12) Research Directors will cooperate with Strategic Basic Research Program evaluations, accounting examinations by JST, accounting audits by the national government, and similar activities.

(13) Research Directors will cooperate by providing various types of information, responding to interviews, etc. in connection with follow-up evaluations performed some time after project completion.

2.3.5 Requirements and Responsibilities of Research Institutions

Research Institutions (affiliated institutions of Research Directors and Main Research Collaborators) need to make efforts to implement project properly and effectively on implementation of Strategic Basic Research Programs by keeping in mind that the research funds are national government funding and ensuring related national legal compliance.

According to the need, please make necessary arrangements with their Research Institution to obtain consent in advance.

(1) For Domestic Institutions

a. All budget shall be administered by the research institutions as contract budget in accordance with the contract research agreement. Thus, research institutions shall prepare a management / audit system for research expenses based on "Guideline on management and audit of the public Research Expenses in Research Institutions (Practical standard)" (Feb. 15, 2007, Action by Ministry of Education, Culture, Sports, Science and Technology). They shall report its enforcement status, and comply with site investigation about situations such as organization maintenance. For details, please refer to "6.4 Implementation of Proper Systems for Managing and Auditing Research Funds at Research Institutions."
http://www.mext.go.jp/b_menu/shingi/chousa/gijyutu/008/houkoku/07020815.htm

b. In accordance with the "Guidelines for Responding to Misconduct in Research Activities" (August 8, 2006; Council for Science and Technology "Special Committee on scientific misconduct"), Research Institutions shall take measures against misconduct in research activities (fabrication, manipulation, plagiarism, etc.). For details of the "Guidelines for Responding to Misconduct in Research Activities", please refer to the website below;
http://www.mext.go.jp/b_menu/shingi/gijyutu/gijyutu12/houkoku/06082316.htm

c. Implement proper accounting work according to the research contract and the instruction manual provided by JST, while considering flexible and efficient use of budget. For certain items, JST has created rules and guidelines peculiar to these programs from sources like the contract research agreement, administration manuals and so on. As for the items not defined, the Research Institutions receiving Grants‐in‐aid for Scientific Research may follow the handling regulations for Grants‐in‐aid for Scientific Research.

d. Research Institutions shall cooperate when submitting requested reports to JST, when JST investigates their accounting work, or when government audits are to be implemented.

e. Please cooperate with JST in promoting the conclusion of a research contract so that the research will be implemented efficiently.

f. Please make necessary reports to JST when applying for and after obtaining intellectual property rights vested in the research institutions under the research contract in accordance with Article 19 (Japanese version of the Bayh-Dole Act) of the Industrial Technology Enhancement Act.

g. For intellectual property rights resulting from the execution of the contracted research, agreements stipulating attribution to research institutions must be exchanged with the participating researchers. This should be specified and formulated in their employment regulations.

h. JST examines in advance the propriety and methods of a research contract with profit organizations (private enterprises or research institutions specified by JST). This examination results may require the profit organizations to follow the contract method particularly specified by JST. In some cases the profit organization may be considered unreliable for contracts and unable to do research when their financial status is remarkably unstable. In such a case, the Research Team may be forced to be reorganized.

i. Any research institution with which a research contract cannot be concluded is not able to carry out the research.

j. As part of the series of measures taken to prevent scientific misconduct, JST has decided to oblige the researchers and so on, who apply for the call in FY2013 and take part in these programs, to take courses on research ethics. (JST does the procedures necessary for taking the courses.) JST has settled that in case researchers and so on are neglectful of the obligations, stay of execution of all or part of contract research funds might be ordered. Therefore, research institutions are required to cooperate on this matter and shall consent in the contract research agreement that stay of execution of research funds is possible in case participating researchers are neglectful of the obligation.

(Note)
This obligation to take courses on research ethics is applied to the research projects which are selected after FY2013.

(2) For Overseas Research Institutions

a. Overseas research institutions shall prepare a management / audit system for research expenses on their responsibility based on the joint research agreements. Expenditure detail reports are required in English.

b. JST might examine and audit the state of execution and so on during the term of the research contract. Foreign research institutions are required to report on the state of execution and so on at JST's request. Research projects are not able to be implemented at research institutions which are not capable of reporting.

c. From the view of the point of Security Export Control, JST may not conclude joint research agreements with such institutions as Japanese Ministry of Economy, Trade and Industry (METI) announces in the "Foreign User List[1]" (or "End User List").

d. Research projects are not able to be implemented at research institutions which are not capable of

[1] METI has issued "Foreign User List" with the aim of strengthening the effectiveness of catch-all control on goods related to weapons of mass destruction.
http://www.meti.go.jp/english/press/2011/pdf/0901_01a.pdf

concluding joint research agreements.

2.3.6 Project Evaluations

(1) The Research Supervisor shall familiarize himself/herself with research project progress and results, and, enlisting the cooperation of Research Area Advisors and others, perform interim and post-completion research project evaluations. For a project with a research term of five years, the interim evaluation should be conducted around three years after the beginning of research activities, and the post-completion evaluation, immediately following the conclusion of research activities.

(2) In addition to the above, project evaluations may be conducted when deemed necessary by the Research Supervisor.

(3) The results of interim problem evaluations and so on should be reflected in subsequent research plan revisions and resource allocations (including increases or decreases in research budgets, changes in research team structure, etc.). On occasion, measures, like actions taken to coordinate multiple research projects or terminate a research project, may be taken.

(4) After the passage of a certain amount of time following the conclusion of research activities, follow-up examinations will be conducted to look at matters such as how research results have been received and are being applied, and the activities participating researchers have taken up following their project involvement. Based on the results of follow-up examinations, external experts selected by JST will then perform follow-up evaluations.

2.3.7 Research Area Evaluations

Separate and apart from the project evaluations mentioned in 2.3.6, research areas and performance of the Research Supervisor will be examined in research area evaluations. Research area evaluations include interim and post-completion evaluations. Research area evaluations focus on matters such as the state of progress achieved toward the accomplishment of Strategic Objects and conditions with regard to research area management.

2.3.8 Development of the results from CREST and PRESTO into Science and Technology Innovation (Development into ACCEL Program)

Strategic Basic Research Programs starts a new program (ACCEL) which promotes innovation from outstanding research results by innovation-oriented research management from FY2013. It accelerates and deepens research projects and present technological feasibility.

Based on the investigation and apprehension about state of progress or result of each research project by JST, JST may ask to consider the development of research result by the ACCEL program. JST will undertake selection procedure for solicitation as research and development project in the ACCEL program separately.

2.3.9 Other Considerations

(1) RA (Research Assistants)

The 4th Science and Technology Basic Plan states that the national government will strive to achieve as quickly as possible the 3rd Basic Plan objective of enhancing fellowships, teaching assistantships, research assistantships and other forms of financial assistance to help outstanding students pursue graduate studies with a sense of financial security and, in the process, enable 20% of doctoral students (latter stage) to receive aid equivalent to their living expenses.

Given this intent, CREST recommends that when a doctoral student (latter stage) is employed as an RA on a CREST research project, the student's compensation be set at a level approximating living expenses.

Japan's Science and Technology Basic Policy Report
IV. Enhancement of basic research and human resource development
3. Development of human resources to lead S&T
(1) Development of human resources capable of working actively in diverse scenes
(ii) Support for entry into doctoral courses and diversification of career paths
In order to encourage quality students to proceed to a graduate school's doctoral course, it is necessary to ensure various types of career paths so that students may use their expertise not only at their universities but also in industrial sectors or local communities after graduating from their school, in addition to economic support while studying at their graduate school. For this reason, the government will substantially strengthen economic support for doctoral course students, support for career development for students, graduates, etc., and other support.

<Promotional measures>
- The government will increase grant-type economic support, such as fellowships, Teaching Assistants (TA) and Research Assistants (RA), so that quality students may feel secure about proceeding to a graduate school. With this effort, the government will strive to achieve the goal set by the 3rd Basic Plan, i.e., "enabling 20 percent of doctorate course students to receive an amount equivalent to their living expenses." The government will also take measures to reduce the burden of students according to their family budget, such as by tuition reductions, scholarships and loans, and encourage universities to help themselves, such as the use of donations from the private sector.

(2) Career Paths for Young Research Staff with Doctoral Qualifications

The Ministry of Education, Culture, Sports, Science and Technology's basic policy for supporting diverse career paths for young research staff who have doctoral qualifications and are being employed with public research funds (December 20, 2011 Council for Science and Technology, Committee on Human Resources) states that it is necessary to actively support public research institutions and research directors who are using public research funds to employ young research staff with doctoral qualifications in their efforts to secure diverse domestic and overseas career paths for these young research staff members. For more details, please refer to "2.3.4 Responsibilities of Research Directors" and the following URL.
http://www.mext.go.jp/b_menu/shingi/gijyutu/gijyutu10/index.htm

2.4 Research Proposal (Form) Completion Requirements

A list of documentation to submit is shown below. Prepare research proposals by following the research proposal completion requirements beginning on the following page.

Some research areas require to use the original proposal forms. Please use the proposal form of the research area which you are planning to apply. Please refer to "Chapter 4. Research Supervisor's Policy on Calls for Proposals, Selection and Management of the Research Area".

Form No.	Document
1	Research Proposal
2	Research Project Overview
3	Research Initiative
4	Research Project Organization 1
5	Research Project Organization 2
6	Research Budget
7	List of Publications (Research Director)
8	List of Publications (Main Research Collaborator)
9	List of Patents (Research Director & Main Research Collaborator)
10	Other Support
11	Measures for Protecting Civil Rights and Complying with Laws and Regulations
12	Other Special Remarks

- Submit all of documents 1-12 in a single file (PDF) (File sizes should not exceed 3MB in total.)
- Please read “2.2.5 Conflicts of Interest involving Research Project Applicants and the Research Supervisor” or the (CREST -- Attachment) Pre-Submission Check Sheet "Relationships with the Research Supervisor.” If there is even one item for which a judgment cannot be made, submit an inquiry form to the following email address before submitting a research proposal.

Inquiry Form:
http://senryaku.jst.go.jp/teian.html
Contact: rp-info@jst.go.jp

- For more information on how to submit a research proposal, please refer to "Chapter 8 Submitting Application using the e-Rad System”.
- Prior to submitting a research proposal, please confirm understanding of “Chapter 6 Key Points in Submitting Proposals” and “Chapter 7 Duplicated Applications for JST Programs”.

Proposal Preparation Checklist

(CREST – Appendix)

Prior to electronic submission via e-Rad, please ensure that proposals comply with the instructions in the format specified.

Just before the deadline, e-Rad System would be slow due to heavy load. Please give yourself plenty of time to complete submission of proposal.

	Items	Check point	
	Input of general information on the applicant to e-Rad	All necessary information is provided.	□
Form 1	Information on the applicant	All necessary information is provided. Information is matched with e-Rad data.	□
Form 2	Outline of Research Project		□
Form 3	Project Description	Form 3 must fit in 6 A4 sheets	□
Form 4	Research Project Organization 1	All necessary information is given (Particularly, effort is provided).	□
Form 5	Research Project Organization 2	All necessary information is given (Particularly, Institution Code, Researcher ID No. and effort are provided).	□
Form 6	Budget Plan	Total Sum is matched with the research budget given in Form 1.	□
Form 7	List of Publication (of Research Director)	Form 7 must fit in 2 A4 sheets	□
Form 8	List of Publication (Main Research Collaborator(s))	Form 8 must fit in 1 A4 sheet per Main Research Collaborator.	□
Form 9	Patent List (Research Director, Main Research Collaborator(s))	Form 9 must fit in 1 or 2 A4 sheet(s)	□
Form 10	Information on Other Supports		□
Form 11	Protection of Human Rights and Compliance with Laws and Regulations		□
Form 12	Additional Statement	Form 12 must fit in 2 A4 sheets	□

Please apply the proposal after checking all necessary information is provided. Imperfect proposal might be not accepted.

Save Form 1 to 12 in one PDF file with less than 3 MB size and upload via e-Rad.

Relationship with Research Supervisor (and Deputy Research Supervisor)

Please be sure that the relationship between the applicant and research supervisor does NOT match any of the following situations. Please contact us in advance if you have any doubts.

Inquiry Form: http://senryaku.jst.go.jp/teian.html

Contact: rp-info@jst.go.jp

Items	Situations	
a	Research Supervisor is a relative of the applicant.	□
b	Research Supervisor and the applicant belong to the same minimum unit of an organization such as the same laboratory at a university or Research Institution including a national institute, or the same corporation;	□
c	Research Supervisor and the applicant are currently conducting close collaborative research or have conducted close collaborative research within the past 5 years. (For example, Research Supervisor and the applicant are regarded to be in the same research group such as in cases where they participate in a collaborative project, jointly write research papers, or conduct research with the same objective, or in cases where they share the same research subject.)	□
d	Research Supervisor and the applicant have had close supervisory relationships, or direct employment relationships, for totaling 10 years or more. A “close supervisory relationship” is considered to be one in which both individuals are affiliated with the same research laboratory. Periods in which Research Supervisor gives substantial guidance to the applicant, even if they belong to different laboratories, are also included.	□

Instruction for research proposal preparation　　　区分４

(CREST-Form 1)

FY 2013 Application CREST Research Proposals

Research Area	Select the Research Area you wish to submit the proposal.	
Title of proposed research project	The title of the project must be brief with approximately 10 words, scientifically or technically valid, intelligible to a scientifically or technically literate reader, and suitable for use in the public press.	
Name of Research Director	The applicant's name (Last, First)	
Affiliated Institution, Section, Title	Name of research institution where the applicant belongs and will carry out the proposed research project. Do not abbreviate.	
Researcher ID No.	Enter ID number provided by Grant-in-Aid for Scientific Research <Kakenhi ID>. For those who do not have this ID number, enter the 8-digit "e-Rad" login ID which is provided by registering researcher information on the e-Rad system.	
Academic Background	List the applicant's undergraduate and graduate education as indicated below: Year: Undergraduate Institution, Major Degree, Supervisor Year: Graduate Institution, Major Degree, Supervisor	
Professional Appointments	List, in chronological order, all academic/professional appointments of the applicant finishing with the current appointment. Include the name of a project leader or a supervisor who had/has been at a mentoring position for the given appointment.	
Research Period	Enter beginning and ending time periods (month and year) of the proposed research project. The beginning period of the awarded projects is October, 2013 or later. [mm. yy] – [mm. yy]	
Total Research Budget	Total Budget: __________ million yen	
Eligibility regarding the relationship with the Research Supervisor (and Deputy Research Supervisor)	□ I am eligible	Please be sure that the relationship between the applicant and research supervisor (and deputy research supervisor) does NOT match any of the situations listed in Proposal Preparation Checklist a to d.

- **Proposed Research Area**
  Only one application may be submitted across all the Research Areas in CREST and PRESTO.
- **Researcher ID No.**
  Proposals must be submitted via the e-Rad system. Those who do not have Kakenhi ID or e-Rad login ID should contact their affiliated Research Institution personnel or the e-Rad Helpdesk immediately to obtain the e-Rad ID. See Chapter 8 in this guideline.
- **Academic Background & Professional Appointments**
  Make sure to list the names of the supervisor / the head of the affiliated research laboratory.
- **Research period**
  The ending time period of research projects can be set to an arbitrary date prior to March 31, 2019 (default).

(CREST-Form 2)

Outline of Research Project

○ **Outline of Research Project**

Summarize the proposed research project described in “Project Description” (CREST-Form 3) in approximately 800 words.

● **References**

Provide the names of two (2) individuals who have good knowledge of your Research Project (non-Japanese person(s) are acceptable). Provide names of the reference person, institution and contact information (phone/fax numbers and e-mail address). The evaluators (Research Supervisor and Research Area Advisors) may contact them regarding the research proposal during the screening process. Providing this reference information is not mandatory.

(CREST-Form 3)

Project Description

- State clearly the work to be undertaken. Graphics and tables may be included if necessary. However, the file size of this Research Proposal application form must be 3MB or less.
- The Form 3 may not exceed 6 pages.
- Font size is restricted to no smaller than 11-point
- In the Project Description, please refer the description listed in Form 7 and 8.

1. Target and Objectives

Describe specifically:
- Objectives and goals of the proposed research project (expected achievements), and
- Significance in terms of the impact on the advancement of science and technology, potential benefits to society and creation of innovation resulting directly from above mentioned achievement.

2. Background

Describe scientific and technological needs, social demand and requests from economic and industrial interests, including the trends of the related fields to illustrate the importance and necessity of the proposed research project.

3. Research Plans and Approach

Describe the plans of the proposed research project.
- Show the outline of the time schedule to demonstrate your vision and plan specifically, how to attain "1. Target and Objectives ", while indicating milestones of research toward "1. Target and Objectives." Also, show clearly the goal to be achieved after 3 years from research start. This is one of the evaluation basis.
- Include probable challenges in accomplishing the objectives and goals and solutions for them.
- Questions and their solutions likely to be addressed for the achievement of "1. Target and Objectives." should be contained.
- It is possible to describe them per every research subject.
- Strategy to acquire intellectual property rights. Describe relevant intellectual property rights that the proposers own.

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4. Research infrastructure and preparation

Describe research background and achievements of the Research Director and other participants that are relevant to implement the proposed research project including the following information;

- Relevant projects conducted in the past and achievements of your own research efforts (and those of other research participants, if necessary)
- Other preliminary knowledge, data, etc. (if any)
- Measures taken to the item “d” in “2.2.7　Selection Perspective”

5. Originality and novelty of the proposed research and comparison to current state of similar studies

Take into account the situation and trends of research in relevant fields, present originality and novelty of the proposed research project, and its advantages over others.

６．Future Prospect of Research

Describe expected creation of science and technology innovation, creation of new industry, acquirement and enforcement of intellectual properties, contribution to society, etc., which are likely realized in the future, by success of the achievement of the “1. Target and Objectives” in the Project Description

(CREST-Form 4)

Research Project Organization 1

(Research framework at Research Director's Group)

Research Director's Group (example)

Research Institution	*Department of Physics, Graduate School of Science, University of JST*		
Participants from the Research Institution	**Name**	**Title**	**Effort (Research Director only)**
(Research Director →)	*John Smith*	*Professor*	30%
	Taro Yamada	*Assistant Professor*	-
	TBA (2)	*Postdoctoral researcher*	-

- "Effort" indicates the percentage of time required by a researcher to engage in the research when his/her total annual work hours is 100%. "Total work hours" refers to the overall substantial work time including education, medical care and other activities and not only the time spent for research activities. (According to the definition set by Council for Science and Technology Policy)
- Give sufficient consideration to the roles played by the members of your Research Team.
- Researchers who plan to participate but have not decided by the time of application (e.g., postdoctoral researchers to be employed) may be indicated as "TBA" with the number of participants at that position.
- Add rows to the list of research participants if necessary.

Note

- When special duties (managerial positions, such as the dean, chairperson of an academic society, etc.) take working hours (effort), explain the situation and reason.

Research subjects and overview

・ **Title of research subjects in charge**

・ **Overview**

Describe briefly an overview of the research subjects that the Research Director's Group will be in charge of.

Role in the entire research project

Describe the role which the Research Director's group plays in realizing the proposed research project.

(CREST-Form 5)

Research Project Organization 2

(Research framework at the Collaborative Research Group)

- If participants belong to the institution other than the Research Director's, list the participants per each institution and organize a collaborative research group.
- The collaborative research groups from various institutions such as industries, governments, and academia can be included in Research Director's team.
- Although there is no maximum limit of the number of the collaborative research groups, compose a necessary and sufficient number of groups for execution of Research Director's research idea. If Research Director does not play a leading role, or if assigned tasks of the collaborative research groups are not clear, the framework of team is inappropriate.
- If necessary, add Form 5 .
- It is not mandatory to have collaborative research groups to the research team.
- Describe measures taken to the item "d" in "2.2.7 Selection Perspective"

Collaborative Research Group (1)

(Example)

Collaborative Research Institution	Center for Advanced Nanotechnology, Senryaku National Laboratory (Institution No. 1))		
Participants from the Research Institution	**Name**	**Title**	**Effort (Main Research Collaborator only)**
(Main Research Collaborator →)	Jane Doe (Researcher ID No. 2))	Chief Scientist	20 %
	Ichiro Suzuki[3)]	Researcher	–

1) Main Research Collaborators shall write in Institution No. of the e-Rad system, if any.
2) Main Research Collaborators shall write in ID number provided by Grant-in-Aid for Scientific Research <Kakenhi> or the e-Rad system, if any.
3) Add rows to list participants if necessary.

Research subjects and overview

- **Title of research subjects in charge**
- **Overview**

Describe briefly an overview of the research subjects that this collaborative research group will be in charge of.

- **Role in the entire research project and necessity**

Describe the role which this collaborative research group plays in realizing the proposed research project.

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(CREST-Form 5 cont.)

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Collaborative Research Group (2)

(Example)

Collaborative Research Institution	Central Research Laboratory, KISOKEN Ltd. (Institution No. 1))		
Participants from the Research Institution	**Name**	**Title**	**Effort Main Research Collaborator only**
(Main Research Collaborator →)	Joe Bloggs (Researcher No. 2))	Senior Researcher	15 %
	Erika Mustermann3)	Researcher	–

1) Main Research Collaborators shall write in Institution No. of the e-Rad system, if any.

2) Main Research Collaborators shall write in ID number provided by Grant-in-Aid for Scientific Research <Kakenhi> or the e-Rad system, if any.

3) Add rows to list participants if necessary.

Research subjects and overview

- **Title of research subjects in charge**
- **Overview**

Describe briefly an overview of the research subjects that this collaborative research group will be in charge of.

- **Role in the entire research project and necessity**

Describe the role which this collaborative research group plays in realizing the proposed research project.

(CREST-Form 6)

Budget Plan

- Prepare the budget plan and sort it by items and by groups for each year.
- A more detailed budget plan will be requested when the proposal proceeds to the interview.
- The budget plan, after adopted, may be revised during the research period according to the state of the project, Research Area policy, and project evaluation, etc.
- Organize an optimal research team with necessary and sufficient number of groups. Appropriateness of the budget allocations to the collaborative research groups, and cost performance will be an important consideration as a part of the selection process.
- Describe measures taken to the item “d” in “2.2.7 Selection Perspective”

Research Budget plan by item (entire team)

(Example)

	1st Year (2013.10 -2014.3)	**2nd Year** (2014.4 -2015.3)	**3rd Year** (2015.4 -2016.3)	**4th Year** (2016.4-2017.3)	**5th Year** (2017.4-2018.3)	**Final Year** (2018.4-2019.3)	**Total** (Million Yen)
Equipment	30	40	40	10	10	0	130
Materials /Consumables	5	10	10	10	8	4	47
Travel	3	5	5	5	5	5	28
Personnel and Services (Number of Researchers)	5 (3)	10 (3)	20 (5)	20 (5)	10 (3)	10 (3)	75
Other	2	10	10	10	7	7	46
Total（Million Yen）	45	75	85	55	40	26	326

Budgeted costs are itemized as follows:

Equipment: Cost for tangible properties with relatively expensive

Materials / Consumables: Cost for purchasing materials and consumables

Travel: Travel expenses of the Research Director or participants.

Personnel and Services: Personnel expenses and compensation for postdoctoral researchers, technicians, research assistants(RA*), etc.

*As for RA, please refer to “2.3.3 Research Costs”.

(Numbers of researchers): The number of researchers, technicians, and research assistants who are newly employed for the proposed research project

Other: Costs other than the above (e.g., printing, equipment lease, freight costs, etc.)

Note

- When “Personnel and Services” exceeds 50% of the total budget, or when either of “Material/ Consumables” or “Travel” exceeds 30%, justify it by providing detailed cost estimation and additional information herein.
- If the total requested budget exceeds 500 million yen, describe the "needs for large budget” herein.

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(CREST-Form 6 cont.)

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Research Budget plan by group

	1st Year (2013.10 -2014.3)	**2nd Year** (2014.4 -2015.3)	**3rd Year** (2015.4 -2016.3)	**4th Year** (2016.4-2017.3)	**5th Year** (2017.4-2018.3)	**Final Year** (2018.4-2019.3)	**Total** (Million Yen)
Research Director Group	25	35	40	35	20	16	171
Collaborating Research Group (1)	10	20	25	10	10	5	80
Collaborating Research Group (2)	10	20	20	10	10	5	75
Total（Million Yen）	45	75	85	55	40	26	326

List of major equipments costing 5 million yen or more (item, estimated cost)

(Example)

XXXXXX 15 M Yen (Million Yen)
XXXXXX 5 M Yen
XXXXXX 10 M Yen
XXXXXX 5 M Yen
XXXXXX 10 M Yen
XXXXXX 5 M Yen

(CREST-Form 7)

List of Publication (of Research Director)

List "Major publication" and "Other reference publication" within 10 papers for each.

● Major publication

List author(s) (all authors), title, title of journal/book, volume and page numbers, and published year.
Refer appropriately in the Form 3.

● Other reference publication

In addition to the above, list any relevant and recent publications that helps understanding the proposed research project or that represent Research Director's research work. (Place an asterisk (*) at the beginning of the title of the papers / books of which the Research Director is the first author (if any)).
List author(s) (all authors), title, title of journal/book, volume and page numbers, and published year.

● Results of Post Evaluations of Research Project served as Principal Investigator of competitive research funding programs and so on (only those which were open to public after FY2009.)

Names of competitive research funding programs and so on, name of research projects and URLs of Post Evaluations

(CREST-Form 8)

List of Publication

(Main Research Collaborator(s))

List selected publications of the Main Research Collaborator, in reverse-chronological order, which are mainly considered to be relevant to the proposed research project and published in recent years.
List author(s) (all authors), title, title of journal/book, volume and page numbers, and published year.
Do not exceed 10 papers for each Main Research Collaborator.

(CREST-Form 9)

Patent list

(Research Director and Main Research Collaborator(s))

● **Major patents**

Application number, inventor, title of invention, applicant, and date of application

List important patent applications of recent years that are considered to be related to this proposal. Do not exceed one page.

- **Research Director**

- **Main Research Collaborator(s)**

(CREST-Form 10)

Information on Other Supports

List grants from the government competitive research funds and any other research subsidies (including CREST and PRESTO) that the Research Director and/or Main Research Collaborators are currently receiving, applying for, or planning to apply for by program name, indicating the title of project, research period, roles, amount of annual budget, and effort. Your entitlement to the JST funds may be cancelled at a later date even if you have been selected should your presentation fail to be accurate.

(Note)

- Please refer to Chapter 6 in this guideline about "Unreasonable Duplication and Excessive Concentration".

- Contact JST (rp-info@jst.go.jp) at any time during the selection process, if any information provided in this form has changed for any reason, including, for example, that a listed research fund being applied for has been granted.

- In case of proceeding to the interview, proposal, research plan and so on of other supports might be required.

(Example)

Research Director (Proposer): Name: _________

Program [1]	Status[2]	Title of Project (Name of principal investigator)	Research Period	Role[3] (Principal Investigator or co-Principal Investigator)	(1) Allocated Budget[4] (For entire period) (2) FY 2014 (planned) (3) FY 2013(planned) (4) FY 2012	Effort (%)[5]
Grants-in-Aid for Scientific Research, Fundamental research (S)	Awarded	XXXXXXXX	2010.4 - 2015.3	PI	(1) 100 M yen (2) 25 M yen (3) 25 M yen (4) 5 M yen	20
					(1) (2) (3) － (4) －	-
7)						

1) List grants that the proposer is currently receiving, or selected, in descending order of amount of allocated budget (for the entire period). Then list those the proposer is currently applying for or planning to apply for (specify "submitted" or "preparing" in the column "Program").

2) Type "Awarded" if it is currently awarded or decided to be awarded, and type "Submitted" for other status.

3) Describe directorship or allocated work as "Role."

4) Enter the amount of allocated budget (direct cost)."

5) Enter "Effort" value of "Awarded" grants. Describe effort for grants the proposer is currently receiving assuming that the CREST proposal is selected.

6) "Effort" indicates the percentage of time required by a researcher to engage in the research when his/her total annual work hours is 100%. "Total work hours" refers to the overall substantial work time including education, medical care and other activities and not only the time spent for research activities. (According to the definition set by Council for Science and Technology Policy). Do not enter efforts of the programs applying for, or planning to apply for. Enter only the efforts which is receiving or planning to receive on the assumption that only the CREST program is selected.

7) Add rows if needed.

(Continued on the next page)

(CREST-Form 10 cont.)

(Continued from the previous page)

Main Research Collaborator (1): Name: _________

Program [1]	Status[2]	Title of Project (Name of principal investigator)	Research Period	Role[3] (Principal Investigator or co-Principal Investigator)	(1) Allocated Budget[4] (For entire period) (2) FY 2014 (planned) (3) FY 2013 (planned) (4) FY 2012	Effort (%)[5]
Health and Labuor Sciences Research Grants	Awarded	XXXXXXXX	2011.4 - 2015.3	PI	(1) 50 M yen (2) 20 M yen (3) 20 M yen (4) 5 M yen	10
					(1) (2) (3) (4)	

Main Research Collaborator (2): Name: _________

Program [1]	Status[2]	Title of Project (Name of principal investigator)	Research Period (fiscal year)	Role[3] (Principal Investigator or co-Principal Investigator)	(1) Allocated Budget[4] (For entire period) (2) FY 2014 (planned) (3) FY 2013 (planned) (4) FY 2012	Effort (%)[5]
					(1) (2) (3) (4)	

(CREST-Form 11)

Protection of Human Rights and Compliance with Laws and Regulations

- Describe the measures and actions that you will take if your research involves compliance with the related laws and regulations (e.g. research requiring the consent and the cooperation of the other party when implementing the research plan, research requiring consideration for the handling of personal information and research requiring efforts regarding bioethics and safety measures).
- This applies to surveys, research, experiments which require an approval procedure in an ethics committee inside and outside the research institution, such as for example questionnaire surveys in which personal information is involved, interview surveys, the use of provided samples, analysis study of the human genome, recombinant DNA experiments, experiments on animals, etc.
- Please indicate where this is not applicable.

(CREST-Form 12)

Additional Statement

- State the reason(s) why you have applied for CREST, any requests concerning your research, or any other concerns that you might have.
- In case this proposal is the second or the third one to the same research area, please state points of difference from the previous proposal.
- If participation of overseas collaborative research group(s) is planned, describe reasons and necessities.
- List any outstanding record of awards here. (Optional)
- Do not exceed two pages for this section.

Chapter 3 PRESTO Program

3.1 PRESTO

3.1.1 PRESTO Overview

Key points and characteristics of PRESTO are discussed below.

a. PRESTO promotes directed basic research that is unique, challenging, and among the most advanced of its kind in the world, in order to accomplish objectives in Strategic Objects designated by the national government. PRESTO promotes the pursuit of research through a network of individuals who, through the network, are working to produce world-class, groundbreaking results that will give rise to science and technology innovation.

b. Research areas are overseen by a Research Supervisor, who manages individual researchers and oversees research areas in a virtual research institute.

The Research Supervisor, in his/her role as director of a virtual research institute, enlists the cooperation of Research Area Advisors and others in managing research areas through the following activities.

- Specification of a management direction for individual research areas
- Research project selection
- Refinement and approval of research plans (including research costs)
- Holding research area meetings at which individual researchers report on their research progress and have their results discussed, visiting labs where research is being performed, and taking other opportunities as well to communicate with individual researchers and provide them with advice and guidance on their efforts.
- Research project evaluation
- Other activities necessary to support research activities in various ways

c. Individual researchers, in pursuing the research initiatives they have proposed, and taking responsibility for implementing their own research projects, pursue research that will contribute to the overall purposes of the research area.

3.1.2 Program Scheme of PRESTO

(1) Research Budgets

The budget for one research project basically ranges from 30 million yen to 40 million yen (for entire research periods up to three and a half years). In addition, JST, under contract research agreements, pays research institutions funds equal to 30% of the research budget (direct cost) to cover overhead (indirect cost).

- ➢ Proposed research budgets are examined as part of the selection process. Actual research budgets are determined in research project planning. For more details, please refer to "3.3 After Selection: Proceeding with Research Work".

(2) Research Period

Research periods may last up to three and a half years (but may extend to the end of the fourth year).

※ Actual research periods depend on research project plans. For more details, please refer to "3.3 After Selection: Proceeding with Research Work".

(3) Research Organization

a. The researcher will pursue his/her research as an individual (alone). (When necessary, however, a research assistant may be appointed and paid for out of the research budget.)

b. JST conducts activities necessary for supporting research. Examples of the matters they may address include research labs and approaches, research-related public relations and outreach activities, and applications for patents.

c. Decisions with regard to research labs will be made with consideration of research details and research environments, and will be based on consultations with the researcher and the research institution where research work will be performed. It is possible for research work to be performed outside of the research institute with which the researcher is affiliated.

3.1.3 Program Flow of PRESTO

(1) Solicitation and Selection of Proposals

JST solicits research proposals for individual research areas specified among the Strategic Objects designated by the national government. Selection of proposals is made by the Research Supervisor, with the cooperation of Research Area Advisors and others, for individual research areas.

- ➢ For more details, please refer to "3.2 Solicitation and Selection of Proposals".

(2) Research Plan Preparation

Once a proposal has been selected, the researcher prepares an overall research plan covering the entire period of the research project. The researcher also prepares annual research plans for each year of the project. Research plans cover budgets and research approach.

- ➢ For more details, please refer to "3.3.1 Research Plan Preparation".

(3) Agreements

In advancing a research project, JST will enter into a contract research agreement with the research institution where the researcher will pursue research work.

- ➢ For more details, please refer to "3.3.2 Agreements".

(4) Research Work

Research work is to be performed over a period of three and a half years (but may extend to the end of the fourth year).

(5) Evaluation

The Research Supervisor will familiarize himself/herself with the status and results of individual research projects and, with the cooperation of Research Area Advisors and others, produce post-completion evaluations immediately following the conclusion of research work. In addition to research project evaluations, research area evaluations are performed to examine research areas and the Research Supervisor.

- For more details, please refer to "3.3.7 Research Project Evaluations" and "3.3.8 Research Area Evaluations".

3.2 Solicitation and Selection of Proposals

3.2.1 Eligible Research Proposals

(1) Research proposals are solicited for the eleven research areas (research areas introduced in fiscal years 2011, 2012, and 2013 mentioned in "Chapter 1 Introduction 1.2 Research Areas for which Research Proposals are Solicited.".

(2) Carefully read the "Research Area Outline" for each of the research areas mentioned in "Research Supervisor's Policy on Calls for Proposals, Selection and Management of the Research Area" of "Chapter 4 Research Areas " before proposing research appropriate for one of the research areas.

3.2.2 Solicitation Period

April 18 (Thr.) to June 11 (Tue.) (12:00 noon) 2013 (No exceptions).

For information on schedules for briefings, calls for proposals, etc., please refer to "1.3 Solicitation and Selection Schedule".

3.2.3 Numbers of Research Projects

The 2013 solicitation for research proposals is planned to select around 100 proposals for 11 research areas.

- The number of proposals selected may vary depending upon budgetary and other factors.

3.2.4 Proposal Submission Requirements

Requirements for those submitting proposals are discussed below.

When submitting a proposal, please do so based on an understanding of the points below and "Chapter 6 Key Points in Submitting Proposals" and "Chapter 7 Duplicated Applications for JST Programs".

(1) Requirements for Research Project Applicants

a. A research project applicant must be the person himself/herself who is going to be the individual researcher.

b. A research project applicant must be the proposer of the subject research initiative and be the researcher who will independently perform research work in pursuit of the research initiative.

  - Researchers who, because of responsibilities as the head of a research lab, or for other such reasons, cannot devote themselves to the pursuit of proposed research may be excluded from consideration.

c. Research project applicants must hold Japanese citizenship or be a foreign researcher who will pursue research work within Japan.

- Researchers holding Japanese citizenship:

For proposals to perform research work at an overseas research institution, it must be possible for the subject research institution to enter into a joint research agreement with JST. For more details, please refer to the next item (2) and the Q&A section at the end of this volume.

- Foreign researchers who will pursue research work within Japan:

Once selected, it will be necessary to perform the proposed research work at a domestic Japanese research institution and it must be possible to perform the proposed research work at a domestic Japanese research institution through the conclusion of PRESTO research. It will also be required that administrative tasks be handled in the Japanese language (or that the researcher's working environment allow for this.)

➢ Japanese researchers who will perform research work at an overseas research institution and foreign researchers who will perform research work at a domestic Japanese research institution must make their own arrangements for visas, visa renewals, visa changes, etc. Failure of a researcher to properly meet visa requirements may result in the rejection of a research proposal or the suspension of a research project.

(2) Requirements for Performing Research Work at an Overseas Research Institution

The performance of research at an overseas research institution requires fulfillment of the following two conditions and the approval of the Research Supervisor. If it is desired that research be performed overseas, the reasons for performing work overseas should be provided in the research proposal (Form 7). Failure to obtain the Research Supervisor's approval or a determination that an agreement cannot be entered into may result in the rejection of a research proposal or the suspension of a research project.

a. The performance of research work at a foreign research institute is judged essential for the pursuit of the researcher's research initiative; pursuit of the researcher's research initiative would be impossible at other than the foreign research institute.

b. An agreement can be concluded between the subject research institute and JST.

➢ Please refer to "3.3.2 Agreements (2) For Overseas Research Institutions" for the detail of conclusion of contract research.

3.2.5 Conflicts of Interest Involving Research Project Applicants and the Research Supervisor

Research project applicants shall be excluded from selection consideration when involved in a relationship involving a Research Supervisor, as described in a. through d. below. When it is unclear whether a condition applies, an inquiry form should be made to rp-info@jst.go.jp before submitting a research project proposal.

Inquiry Form

http://www.senryaku.jst.go.jp/teian.html

a. The research project applicant is a relative of the Research Supervisor.

b. The research project applicant and the Research Supervisor are both affiliated with the same smallest organizational unit (e.g. same research lab) of a university, national or other national government-funded research and experiment institution. Or, the research project applicant and the Research Supervisor are affiliated with the same company.

c. The research project applicant and the Research Supervisor are presently working in close cooperation on the same joint research project. Or, have done so within the past five years.

(For example, the research project applicant and the Research Supervisor are working together on the same research project, are performing different parts of the same research project, or are co-authors of a research paper.)

d. The research project applicant and the Research Supervisor were in a close teacher-student relationship for a total of more than ten years (not necessarily continuous), or were in a direct employer-employee relationship. “Close teacher-student relationship” means cases in which the research project applicant and the Research Supervisor were affiliated with the same research lab, and cases in which the Research Supervisor, though affiliated with a different lab, essentially functioned as a research advisor for the research project applicant.

- For Research Areas in which Deputy Research Supervisors have been established, the same provisions shall apply when the relationships described are found to exist.
- For inquiries submitted by May 10, responses as to whether any of the relationship conditions described above have been violated shall be provided by the proposal deadline. For inquiries submitted after May 10, such responses may not be provided by the proposal deadline. Acceptance of research project proposals may be canceled if it is determined following the proposal deadline that any of the relationship conditions described above have been violated.
- Please make use of the (PRESTO - Attachment) Pre-Submission Check Sheet “Relationships with the Research Supervisor.

3.2.6 Selection Method

For schedule information, please refer to "1.3 Solicitation and Selection Schedule”.

(1) Selection Process

For each Research Area, the Research Supervisor, enlisting the cooperation of Research Area Advisors and others, shall select research proposals in two stages– one based on documentation and the other based on interviews. When necessary, other examinations, etc. may also be conducted. In addition, the cooperation of external evaluators may also be enlisted. (In case research project proposers belong to profit-making-institution etc., financial statements may be required to submit.) JST shall select researchers and research projects based on this process.

The names of Research Area Advisors shall be posted on the research proposal solicitation homepage as soon as they become available.

http://www.senryaku.jst.go.jp/teian.html

(2) Persons Involved in the Selection Process

To ensure fair and transparent evaluations, the following interested parties shall be excluded from the selection process, based on relationships with research project applicants, in accordance with JST rules.

a. Relatives of research project applicants.

b. Persons who were in the same department or research lab as a research project applicant at a university, national and other national government-funded research and experiment institution, or who were affiliated with the same company.

c. Persons who worked in close cooperation on a joint research project with a research project applicant. (For example, a person who worked on a joint research project, co-authored a research paper, worked toward the same objectives as a member of the same research team, performed different parts of the same research project, or were otherwise essentially affiliated with the same research group as a research project applicant.)

d. Persons who were in a close teacher-student relationship, or were in a direct employer-employee relationship, with a research project applicant.

e. Persons in relationships of direct competition with a research project of a research project applicant.

f. Persons in other relationships judged by JST to represent conflicts of interest.

(3) Interview-Based Selections and Notification of Selection Results

a. Research project applicants who have been selected for participation in the interview phase of the process based on documentation-based selection results, shall be notified of their selection in writing. They will also be provided with an overview of the interview process, schedule information, and instructions regarding matters like the submission of additional information. Information on the schedule for the interview-based selection phase shall be posted on the research proposal solicitation homepage (http://www.senryaku.jst.go.jp/teian.html) as soon as it becomes available.

b. In the interview, the research project applicant shall be asked to explain the proposed research initiative. As part of that explanation, the research project applicant should also provide a figure for the desired overall research budget covering the entire research project period. It should be noted that interviews shall basically be conducted in Japanese, but that English may be used when conducting the interview in Japanese is impractical.

c. Research project applicants who are not selected in either the document-based or interview-based selection phases shall be notified in writing. In addition, rejection reason shall be posted separately.

d. Research project applicants who are selected shall be notified of their selection in writing and provided with information on procedures for commencing research.

3.2.7 Selection Perspective

(1) Selection Standards (Preliminary Evaluation Standards)

Common selection standards for all PRESTO Research Areas are described below. <u>(All standards described in a. through e. must be met.)</u>

a. Contributes to the achievement of Strategic Objects.

b. Consistent with the Research Area intent (Refer to Addendum 1. Addendum 2.)

c. Basic research that is unique, challenging, internationally expected to develop at an advanced level, and can be expected to produce groundbreaking results (Refer to Addendum 3.) that lead to science and technology innovation.

d. The research project applicant can be expected to contribute to the development of the subject overall PRESTO Research Area and to the ongoing development of related research fields through the content of the proposed research, the applicant's research approach, and the applicant’s efforts to engage with other researchers in discussions and activities that mutually inspire.

e. Meets all of the following conditions.

- The uniqueness of the research project applicant is based on the original ideas of the research project applicant.
- Promising preliminary results have been obtained for pursuing the research initiative.
- The proposed research project is of a scale appropriate for pursuit by an individual researcher.

《Addendums》

1. Regarding item b. “Research Area intent,” please refer to “Research Area Outline” and “Research

Supervisor's Policy on Calls for Proposals, Selection and Management of the Research Area" mentioned in "Chapter 4 Research Areas for which Proposals will be Solicited" for individual Research Areas. Contained therein are discussions of selection perspectives and policies, management directions, etc. for individual Research Areas.

2. Whether the research project structure fits with the desired research project structure to optimize the entire research area under the policies and directions discussed above is another selection perspective.

3. The "results" sought for Strategic Basic Research Programs are new technologies.

"New technologies" are science and technology R&D results that are viewed as significant for the nation's economy, but have not yet entered commercialization development (have not undergone commercial-scale testing used in commercial production).

- < "New technologies" and "commercialization development" are terms used (as rendered in Japanese) in the text of the Act on the Japan Science and Technology Agency, Independent Administrative Agency.>

(2) Whether research budgets are characterized by "unreasonable duplication" or "excessive concentration" is a selection criterion. For more details, please refer to "6.2 Unreasonable Duplication and Excessive Concentration".

3.3 After Selection: Proceeding with Research Work

3.3.1 Preparing a Research Plan

a. Once selected, the individual researcher will prepare an overall research plan covering the entire research project period (up to three and a half years). The researcher will also prepare annual research plans. Research plans include information on the research budget and so on.

b. Research plans (overall and annual plans) become official once they are checked and approved by the Research Supervisor. The Research Supervisor will offer advice and coordination assistance on the research plan, and provide instructions when necessary, based on information the Research Supervisor gains through, for example, the project selection process, discussions with the individual researcher, regular progress updates, and the results of research evaluations.

c. The Research Supervisor, in approving research project plans to achieve objectives including the accomplishment of the overall objectives of a Research Area, may merge or link research projects, or take other such coordinative actions.

- Research budgets set forth in research plans may be revised during the research project period in response to overall Strategic Basic Research Program budget conditions, Research Area management actions taken by the Research Supervisor, or factors like results of research evaluations.

3.3.2 Agreements

(1) For Domestic Institutions

a. Once a research project is selected, JST, in principle, will enter into a contract research agreement with the research institutions where the individual researcher will perform research work.

b. If it is not possible to enter into contract research agreements with these research institutions, not possible to put in place the management and audit systems required in connection with the use of public funds, or the subject research institutions are conspicuously financially unstable, it may be impossible to pursue research at the subject research institutions. For more details, please refer to "3.3.6 Employment Terms and Conditions for Selected Individual Researchers".

c. Ownership of discoveries, etc. made as a result of PRESTO research, shall, in accordance with contract research agreement terms, be assigned as described below.

1. Researcher with a Joint Appointment

Patents and other intellectual property rights resulting from research shall, in accordance with contract research agreement terms, reside with the research institution under the condition that the research institution abide by the items provided in Article 19 (Japanese version of the Bayh-Dole Act) of the Industrial Technology Enhancement Act.

2. Researcher with an Exclusive Appointment

Ownership of intellectual property rights shall be determined based on the terms of the agreement entered into with the research institution where the research work was performed.

(Note) Jurisdiction for discoveries depends on rules of each institution.

(2) For Overseas Research Institutions

a. Institutions which meet requirements under "3.2.4 (2) Requirements for Performing Research Work at an Overseas Research Institution" need to conclude agreements fulfilling the conditions below;

1. Payments to the subject overseas research institute to cover overhead costs (indirect cost) will not exceed 30% of direct costs (research costs).

2. The sharing (on a 50%-50% basis) of intellectual property rights between the subject overseas research institute and JST is possible.

3. Overseas research institutions shall prepare a management / audit system for research expenses on their responsibility based on the joint research agreements. Expenditure detail reports are required in English.

b. In case it is not possible to enter into a contract research agreement, the institution is not equipped with the system necessary for manage the research funds, etc., it may not be possible to pursue research at the subject research institution. Please refer to "3.3.6 Research Institution Requirements and Responsibilities" for detail.

c. Intellectual property rights shall be jointly owned by the overseas research institution and JST. JST's ownership share shall, in principle, be shared with the researcher.

3.3.3 Joint appointment and Exclusive appointment

The individual researcher whose research proposal has been selected will become affiliated with JST under joint appointment*[1] or exclusive appointment*[2].

- If necessary, researchers who are planning to submit a research project proposal should notify the research institutions with which they are affiliated, collaborate, etc. of their intent ahead of time.
- If necessary, a researcher may change his/her research institution affiliation or otherwise revise the terms of his/her participation during the research project period.

*1 Joint appointment: The researcher is affiliated with a university, national and public testing and research institution, independent administrative agency, foundation, company, etc. and his/her participation will be based on a concurrent appointment at JST. Based on JST's regulation, JST reward the researcher a fixed amount of money monthly. The researcher shall take out social insurance at his/her affiliated institution.

*2 Exclusive appointment: The researcher is not affiliated with a research institution, company, etc. or will need to resign his/her existing appointment for certain reasons of the organization he/she currently belongs to and will participate as a researcher employed by JST. In order to be an exclusive appointment researcher, employment contract should be signed after the necessity of employment by JST is found eligible. As per JST's regulation, JST reward the researcher with an annual salary scheme. An annual salary includes salary, various allowance, bonus, etc.. As for social insurance, the researcher shall take out health insurance, welfare annuity insurance, employees' pension funds and employment insurance which JST designates.

3.3.4 Research Costs

Research costs shall be covered as contract research fees in payments by JST to research institutions. In addition to amounts covering the "direct cost" discussed in (1) below, JST shall also pay to research institutions an amount equal to 30% of direct cost, in principle, as the "overhead cost" (indirect cost) discussed in (2). In addition, when necessary a portion of research expenditures may be executed by JST.

(1) Research Costs (Direct Cost)

Research costs (direct cost) means costs that are directly related to and required for the pursuit of the subject PRESTO research. Research costs can include:

a. Goods: Costs for the purchase of new equipment, supplies, etc.

b. Travel: Expenses for travel by the individual researcher for purposes necessary for and directly related to PRESTO research. Also, expenses for a participating researcher noted in research plans to travel domestically to report on research results that were obtained by the researcher and are directly related to PRESTO research.

c. Personnel and Services: Personnel expenses for a research assistant performing work directly related to PRESTO research.

d. Other: For example, expenses related to the reporting of research results (research paper submission fees, etc.)

- The following costs are not treated as research costs (direct cost)).
  - Cost for items not consistent with PRESTO research objectives.
  - Costs that are considered to be more appropriately handled as overhead cost (indirect cost).
- For certain items, JST has created rules and guidelines from sources like the contract research agreement, administration manuals, and a common governmental expense categorization table, and asks that these rules and guidelines be applied appropriately. Universities and other organizations (including public research institutions operated by the national government and independent administrative agencies, and public-service corporations and other organizations recognized by JST) and companies (mainly research institutions operated by private companies and other non-university organizations) may differ in their handling of administrative matters. For more details, please refer to the following URLs. (Only in Japanese)

http://www.jst.go.jp/kisoken/contract/top2.html

(2) Carryover

In principle, research activities are to be pursued in accordance with annual research plans. However, in consideration of the occasional difficulty of using the entirety of a particular year's research budget and the waste and inappropriate accounting practices that can emerge from unreasonable efforts to use the entirety of a particular year's research budget, JST has adopted a simple carryover system that requires no troublesome application and approval procedures for carrying over to the following year budgeted funds that were not used because progress in implementing the research plan did not warrant them. (The carryover system is for universities and other organizations that have entered into multi-year agreements.)

(3) Once a research project has been selected, the Research Supervisor, after consulting with the individual researcher, will officially authorize the research plan covering the entirety of the research project period and an annual research plan specifying details on matters including the budget for the first year of the project. For the second and subsequent years of research project, the annual research plan will undergo a similar evaluation and authorization procedure by the Research Supervisor. It should be noted that research budgets may be increased or decreased in response to the Research Supervisor's evaluation or in light of conditions with regard to research progress.

3.3.5 Responsibilities of Individual Researchers

(1) Individual Researchers are responsible for fully recognizing that JST research budgets are funded by precious tax revenues collected from citizens, and for fairly and efficiently executing budgeted expenditures.

(2) Once a proposed research project is selected, the individual researcher shall affirm that he/she will fulfill the following requirements, presented via JST briefings and other means, and submit to JST a written document evidencing this affirmation.

a. Comply with application and other requirements.
b. Acknowledge that JST research budgets are funded with tax revenues collected from citizens, and pledge not to use these funds for activities, applications, etc. that are improper for the pursuit of research.
c. To prevent from engaging in activities (fabrication, manipulation, plagiarism, etc. of research papers) that are improper for the pursuit of research, Individual Researchers shall study JST-designated research ethics education materials (online materials) and pledge to achieve a common understanding that this study is required.

It should be noted that failure to fulfill the research ethics education requirement in c. above can result in the suspension of budgets related to research assistants who have not completed study of the research ethics materials, until it has been confirmed that this study has been completed.

(Note) The submission of written confirmation that this item has been fulfilled and the requirement that research ethics materials be studied apply to research projects selected in 2013 and later fiscal years.

(3) Research Environment and Management

Individual Researchers shall be responsible for arranging research implementation location and environments necessary for promotion of research. When serious obstruction of research implementation location and environments to promote research is found, cancellation of research project may be cancelled.

(4) Pursuing Research and Submitting Research Plans etc.

Individual Researchers shall be responsible for the general pursuit of research work and the production of research results. In addition, Individual Researchers shall prepare research plans and submit regular reports and other communications.

(5) Individual Researchers shall be responsible for matters including oversight of the expenditure and management of funds, the performance of administrative procedures, the management of research assistants, and matters related to travel.

(6) Handling of Research Results

Individual Researchers shall be responsible for reporting on the progress of research work to parties including the Research Supervisor. In addition, researchers shall present research results both inside and outside Japan and actively secure intellectual property rights. When reporting on research results through research papers or other media, researchers should indicate that the research results were obtained via the PRESTO program. Researchers shall participate in JST-sponsored domestic and international workshops and symposia to report on research results.

(7) Individual Researchers shall participate in research area retreats held by the Research Supervisor (twice annually) and engage in activities such as reporting on research results.

(8) Individual Researchers are asked to actively engage citizens in discussions of science and technology to promote citizen understanding and support of science and technology.

(9) Individual Researchers shall abide by research agreements entered into by JST and research institutions or other parties, and shall abide by JST's various rules.

(10) It should be noted that JST will provide research project names, names of researchers, research budget information, and other required information to the Cross-ministerial R&D Management System (e-Rad) and the Government Research and Development Database ("Chapter 6 " Key Points in Submitting Proposals"). Individual Researchers and others, therefore, may be asked to provide various types of information in that connection.

(11) Individual Researchers will cooperate with Strategic Basic Research Program evaluations, accounting examinations by JST, accounting audits by the national government, and similar activities.

(12) Individual Researchers will cooperate by providing various types of information, responding to interviews, etc. in connection with follow-up evaluations performed some time after project completion.

3.3.6 Research Institution Requirements and Responsibilities

Research Institutions need to make efforts to implement project properly and effectively on implementation of Strategic Basic Research Programs by keeping in mind that the research funds are national government funding and ensuring related national legal compliance.

According to the need, please make necessary arrangements with their Research Institution (affiliated institutions of Individual Researchers and institutions where Individual Researchers who conclude exclusive appointments with JST pursuit research) to obtain consent in advance.

(1) For Domestic Institutions

a. In accordance with contract research agreement terms, research institutions shall execute research expenditures in their entirety as contract research expenses*. Research institutions, therefore, shall be responsible for managing research expenditures in accordance with the principle that research institutions bear responsibility for managing competitive funding, set forth in the "Guidelines of Management and Audit of Public Research Funds in Research Institutes (Implementation standards)" (announced February 15, 2007 by the Ministry of Education, Culture, Sports, Science & Technology).

It should be noted that research institutions are required by these guidelines to establish systems for managing and auditing contract research funds, reporting on their activities in this regard to the Ministry of Education, Culture, Sports, Science and Technology, and cooperating with on-site examinations of system implementation and other guideline requirements ("6.4 Implementation of Proper Systems for Managing and Auditing Research Funds at Research Institutions".

* In the case of researchers with exclusive PRESTO appointments, there may be occasions in which the research institute where research work is to be performed is asked to enter into an agreement (joint research agreement, etc.) other than a contract research agreement and to manage research funds in accordance with that agreement.

b. In accordance with the "Guidelines for Responding to Misconduct in Research Activities" (August 8, 2006; Council for Science and Technology "Special Committee on scientific misconduct"), Research Institutions shall take measures against misconduct in research activities (fabrication, manipulation, plagiarism, etc.). For details of the "Guidelines for Responding to Misconduct in Research Activities", please refer to the website below;
http://www.mext.go.jp/b_menu/shingi/gijyutu/gijyutu12/houkoku/06082316.htm

c. Implement proper accounting work according to the research contract and the instruction manual provided by JST, while considering flexible and efficient use of budget. For certain items, JST has created rules and guidelines peculiar to these programs from sources like the contract research agreement, administration manuals and so on. As for the items not defined, the Research Institutions receiving Grants - in - aid for Scientific Research may follow the handling regulations for Grants - in - aid for Scientific Research.

d. Research Institutions shall cooperate when submitting requested reports to JST, when JST investigates their accounting work, or when government audits are to be implemented.

e. Please cooperate with JST in promoting the conclusion of a research contract so that the research will be implemented efficiently.

f. Please make necessary reports to JST when applying for and after obtaining intellectual property rights vested in the research institutions under the research contract in accordance with Article 19 (Japanese version of the Bayh-Dole Act) of the Industrial Technology Enhancement Act.

g. For intellectual property rights resulting from the execution of the contracted research, agreements stipulating attribution to research institutions must be exchanged with the Individual Researchers. This should be specified and formulated in their employment regulations.

h. JST examines in advance the propriety and methods of a research contract with profit organizations (private enterprises or research institutions specified by JST). This examination results may require the profit organizations to follow the contract method particularly specified by JST. In some cases the profit organization may be considered unreliable for contracts and unable to do research when their financial status is remarkably unstable. In such a case, the Research Team may be forced to be reorganized.

i. Any research institution with which a research contract cannot be concluded is not able to carry out the research.

j. As part of the series of measures taken to prevent scientific misconduct, JST has decided to oblige the researchers and so on, who apply for the call in FY2013 and take part in these programs, to take courses on research ethics. (JST does the procedures necessary for taking the courses.) JST has settled that in case researchers and so on are neglectful of the obligations, stay of execution of all or part of contract research funds might be ordered. Therefore, research institutions are required to cooperate on this matter and shall consent in the contract research agreement that stay of execution of research funds is possible in case participating researchers are neglectful of the obligation.

(Note)

This obligation to take courses on research ethics is applied to the research projects which are selected after FY2013.

(2) For Overseas Research Institutions

a. Overseas research institutions shall prepare a management / audit system for research expenses on their responsibility based on the joint research agreements. Expenditure detail reports are required in English.

b. JST might examine and audit the state of execution and so on during the term of the research contract. Foreign research institutions are required to report on the state of execution and so on at JST's request. Research projects are not able to be implemented at research institutions which are not capable of reporting.

c. From the view of the point of Security Export Control, JST may not conclude joint research agreements with such institutions as Japanese Ministry of Economy, Trade and Industry (METI) announces in the "Foreign User List[1]" (or "End User List").

d. Research projects are not able to be implemented at research institutions which are not capable of concluding joint research agreements.

3.3.7 Project Evaluations

(1) The Research Supervisor shall familiarize himself/herself with research project progress and results, and, enlisting the cooperation of Research Area Advisors and others, perform post-completion research project evaluations immediately following the conclusion of research activities.

(2) In addition to the above, project evaluations may be conducted when deemed necessary by the Research Supervisor.

(3) After the passage of a certain amount of time following the conclusion of research activities, follow-up examinations will be conducted to look at matters such as how research results have been received and are being applied, and the activities researchers have taken up following their project work. Based on the results of follow-up examinations, external experts selected by JST will then perform follow-up evaluations.

3.3.8 Research Area Evaluations

Separate and apart from the problem evaluations mentioned in 3.3.7, research areas and performance of the Research Supervisor will be examined in research area evaluations. Research area evaluations focus on matters such as the state of progress achieved toward the accomplishment of Strategic Object objectives and conditions with regard to research area management.

3.3.9 Development of the results from CREST and PRESTO into Science and Technology Innovation (Development into ACCEL Program)

Strategic Basic Research Programs starts a new program (ACCEL) which promotes innovation from outstanding research results by innovation-oriented research management from FY2013. It accelerates and deepens research projects and present technological feasibility.

Based on the investigation and apprehension about state of progress or result of each research project by JST,

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1 METI has issued "Foreign User List" with the aim of strengthening the effectiveness of catch-all control on goods related to weapons of mass destruction.
http://www.meti.go.jp/english/press/2011/pdf/0901_01a.pdf

JST may ask to consider the development of research result by the ACCEL program. JST will undertake selection procedure for solicitation as research and development project in the ACCEL program separately.

3.4 Research Proposal (Form) Completion Requirements

A list of documents to submit is shown below.

Prepare research proposals by following the research proposal completion requirements beginning on the following page.

Form No.	Document
1	Research Proposal
2	Research Project Overview
3	Research Initiative
4	List of publications
5	Other Support
6	Measures for Protecting Civil Rights and Complying with Laws and Regulations
7	Other Special Remark

- Please read "3.2.5 Conflicts of Interest involving Research Project Applicants and the Research Supervisor" or the (PRESTO -- Attachment) Pre-Submission Check Sheet "Relationships with the Research Supervisor." If there is even one item for which a judgment cannot be made, submit an inquiry form to the following email address before submitting a research proposal.

  Inquiry Form:
  http://senryaku.jst.go.jp/teian.html
  Contact: rp-info@jst.go.jp
- For more information on how to submit a research proposal, please refer to "Chapter 8 Research Proposal Submission via Cross-ministerial R&D Management System (e-Rad)".
- Prior to submitting a research proposal, please confirm understanding of "Chapter 6 Key Points in Submitting Proposals" and "Chapter 7 Duplicated Applications for JST programs".

Proposal Preparation Checklist

Prior to electronic submission via e-Rad, please ensure that proposals comply with the instructions in the format specified.

Just before the deadline, e-Rad System would be slow due to heavy load. Please give yourself plenty of time to complete submission.

	Items	Check	
	Input of general information on the applicant to e-Rad	All necessary information is provided.	□
Form 1	Information on the applicant	All necessary information is provided. Information is matched with e-Rad data.	□
Form 2	Outline of Research Project		□
Form 3	Project Description	Form 3 must fit in 5 A4 sheets	□
Form 4	List of Publication and Patent		□
Form 5	Information on Other Supports		□
Form 6	Protection of Human Rights and Compliance with Laws and Regulations		□
Form 7	Additional Statement		□

Save Form 1 to 7 in one MS Word or PDF file with less than 3 MB size and upload via e-Rad.

Relationship with Research Supervisor (and Deputy Research Supervisor)

Please be sure that the relationship between the applicant and research supervisor does NOT match any of the following situations. Please prepare Inquiry Form and contact us in advance if you have any doubts.

Inquiry Form: http://senryaku.jst.go.jp/teian.html Contact: rp-info@jst.go.jp

Items	Situations	
a	Research Supervisor is a relative of the applicant.	□
b	Research Supervisor and the applicant belong to the same minimum unit of an organization such as the same laboratory at a university or Research Institution including a national institute, or the same corporation;	□
c	Research Supervisor and the applicant are currently conducting close collaborative research or have conducted close collaborative research within the past 5 years. (For example, Research Supervisor and the applicant are regarded to be in the same research group such as in cases where they participate in a collaborative project, jointly write research papers, or conduct research with the same objective, or in cases where they share the same research subject.)	□
d	Research Supervisor and the applicant have had close supervisory relationships, or direct employment relationships, for totaling 10 years or more. A “close supervisory relationship” is considered to be one in which both individuals are affiliated with the same research laboratory. Periods in which Research Supervisor gives substantial guidance to the applicant, even if they belong to different laboratories, are also included.	□

Instruction for research proposal preparation

区分4

(PRESTO-Form 1)

FY 2013 Application PRESTO Research Proposals

Research Area	Select the Research Area you wish to submit the proposal.	
Title of proposed research project	The title of the project must be brief with approximately 10 words, scientifically or technically valid, intelligible to a scientifically or technically literate reader, and suitable for use in the public press.	
Name of Applicant	The applicant's name (Last, First)	
Affiliated Institution, Section, Title	Name of research institution where the applicant belongs and will carry out the proposed research project. Do not abbreviate.	
Researcher ID No.	Enter ID number provided by Grant-in-Aid for Scientific Research <Kakenhi ID>. For those who do not have this ID number, enter the 8-digit "e-Rad" login ID which is provided by registering researcher information on the e-Rad system.	
Academic Background	List the applicant's undergraduate and graduate education as indicated below: Year: Undergraduate Institution, Major Degree, Supervisor Year: Graduate Institution, Major Degree, Supervisor	
Professional Appointments	List, in chronological order, all academic/professional appointments of the applicant finishing with the current appointment. Include the name of a project leader or a supervisor who had/has been at a mentoring position for the given appointment.	
Research Budget	Total Budget: __________ million yen (Do not include indirect cost)	
Place to Pursuit Research Work	□ Present Affiliated Institution □ Other (Place to Pursuit Research Work:)	
Eligibility regarding the relationship with the Research Supervisor (and Deputy Research Supervisor)	□ I am eligible	Please be sure that the relationship between the applicant and research supervisor (and deputy research supervisor) does NOT match any of the situations a-d listed in "3.2.5 Conflicts of Interest Involving Research Project Applicants and the Research Supervisor" or "Proposal Preparation Checklist"

- **Proposed Research Area**
  Only one application may be submitted across all the Research Areas in CREST and PRESTO.
- **Researcher ID No.**
  Proposals must be submitted via the e-Rad system. Those who do not have Kakenhi ID or e-Rad login ID should contact their affiliated Research Institution personnel or the e-Rad Helpdesk immediately to obtain the e-Rad ID. See Chapter VII in this guideline.
- **Place to Pursuit Research Work**
  Please check.the place which you plan to pursuit research.
  Applicant who choose "Other" shall be asked when the proposal is selected. JST also accepts consultation prior to submission.

(PRESTO-Form 2)

Outline of Research Project

○ **Outline of Research Project**

Summarize the proposed research project described in "Project Description" (PRESTO-Form 3) in approximately 400 words.

● **References**

Provide the names of two (2) individuals who have good knowledge of your Research Project (non-Japanese person(s) are acceptable). Provide names of the reference person, institution and contact information (phone/fax numbers and e-mail address). The evaluators (Research Supervisor and Research Area Advisors) may contact them regarding the research proposal during the screening process. Providing this reference information is not mandatory.

(PRESTO-Form 3)

Project Description

- State clearly the work to be undertaken. Graphics and tables may be included in the Form 3 if necessary. However, the file size of this Research Proposal application form must be 3MB or less.
- The Form 3 should be less than 6 pages, larger than 11points of font.

1. Target and Objectives

2. Background

Describe circumstances to propose the project, relation to your research so far and so on.

3. Originality and novelty of the proposed research and comparison to current state of similar studies

Describe including the domestic and international research trends in the related research areas.

4. Research Plans and Approach

Describe the necessity of the research, preliminary knowledge or data, specific plans of the proposed research project and the way (including the purpose, the problem and the solution toward achievement of the target .

(Continued on the next page)

(PRESTO-Form 3 cont.)

(Continued from the previous page)

5. Future Prospect of Research

Describe expected developments in science and technology, creation of science and technology innovation, creation of new industry, contribution to society, etc., which are likely realized in the future, by success of the proposed research project.

6. Explanation of Keywords

Describe the explanation of keywords which is thought to be necessary for reviewer to understand the contents of the research.

(PRESTO-Form 4)

List of Publication and Patent

● Major publication

List selected publications of the Research Director, in reverse-chronological order, which are considered to be relevant to the proposed research project and published in recent years.
Place an asterisk (*) at the beginning of the title of the papers / books of which the applicant is the first author.
List author(s) (all authors), title, title of journal/book, volume and page numbers, and published year.

● Other reference publication

In addition to the above, list any relevant and recent publications that helps understanding the proposed research project or that represent Research Director's research work. (Place an asterisk (*) at the beginning of the title of the papers / books of which the applicant is the first author (if any)).
List author(s) (all authors), title, title of journal/book, volume and page numbers, and published year.

● Major Patent

Application number, inventor, title of invention, applicant, and date of application

(PRESTO-Form 5)

Information on Other Supports

List grants from the government competitive research funds and any other research subsidies (including CREST and PRESTO) that the applicant is currently receiving, applying for, or planning to apply for by program name, indicating the title of project, research period, roles, amount of annual budget, and effort. Your entitlement to the JST funds may be cancelled at a later date even if you have been selected should your presentation fail to be accurate.

(Example)

Program	**Status**	**Title of Project (Name of principal investigator)**	**Research Period**	**Role (Principal Investigator or co-Principal Investigator)**	**(1) FY 2012 (2) FY 2013 (planned) (3) Allocated Budget (For entire period) (thousand Yen)**	**Effort (%)[5)]**
PRESTO	Submitted					80
Grants-in-Aid for Scientific Research, Fundamental research (C)	Awarded	XXXXXXXX	2012.4 - 2015.3	PI	(1) 800 (2) 2,000 (3) 4,000	

-List grants that the proposer is currently receiving, or selected, in descending order of amount of allocated budget (for the entire period). Then list those the proposer is currently applying for or planning to apply for (specify "submitted" or "preparing" in the column "Program").

-Type "Awarded" if it is currently awarded or decided to be awarded, and type "Submitted" for other status.

-Describe directorship or allocated work as "Role."

-Enter the amount of allocated budget (direct cost)."

-Enter "Effort" value of "Awarded" grants. Describe effort for grants the proposer is currently receiving assuming that the only PRESTO proposal is selected. Don't exceed 100% in total.

-Add rows if needed.

(PRESTO-Form 6)

Protection of Human Rights and Compliance with Laws and Regulations

- Describe the measures and actions that you will take if your research involves compliance with the related laws and regulations (e.g. research requiring the consent and the cooperation of the other party when implementing the research plan, research requiring consideration for the handling of personal information and research requiring efforts regarding bioethics and safety measures).
- This applies to surveys, research, experiments which require an approval procedure in an ethics committee inside and outside the research institution, such as for example questionnaire surveys in which personal information is involved, interview surveys, the use of provided samples, analysis study of the human genome, recombinant DNA experiments, experiments on animals, etc.
- Please indicate where this is not applicable.

(PRESTO-Form 7)

Additional Statement

- State the reason(s) why you have applied for PRESTO, any requests concerning your research, or any other concerns that you might have. (Optional)
- If participation of overseas collaborative research group(s) is planned, please refer to "3.2.4 Proposal Submission Requirements" and describe reasons and necessities.

(NOTE)

Applicant who is applying for the Research Area "Design and Control of Cellular Functions" (Research Supervisor: Prof. Hiroki Ueda) should download its original Research Proposal from e-Rad Portal Site and refer to the NOTE of its Form 7.

Chapter 4　Research Areas Calling for Proposals

4.1 Green Innovation

Research Area in the Strategic Object:

Creation of core technologies for innovative energy carrier utilization aimed at the transport, storage, and use of renewable energy

4.1.1 "Creation of Innovative Core Technology for Manufacture and Use of Energy Carriers from Renewable Energy" <CREST＆PRESTO >

Research Supervisor: Koichi Eguchi (Professor, Graduate School of Engineering, Kyoto University)

Outline of Research Area

This research area, looking ahead to a hydrogen energy society making stable and efficient use of renewable energy, aims to create fundamental and core technology for efficient conversion of renewable energy to energy carriers that store and transport chemical energy, and for extraction and use of electrical energy, hydrogen, and motive power, etc., from the energy carriers. The research to be carried out to these ends will fuse different fields such as electrochemistry, catalytic chemistry, materials science, and process engineering, without regard to the walls and fences between fields. Examples of the research topics are electrosynthesis, catalyzed synthesis, and electrode and reaction field materials enabling use of renewable energy such as wind power and sunlight for efficient direct synthesis of energy carriers, and synthesis of energy carriers by thermochemical processes using solar heat or the heat of the earth (geothermal energy). Also included in this research area are direct fuel cells, enabling electrical energy to be extracted by using energy carriers as fuel, and dehydrogenation technology for efficient-dehydrogenation of energy carriers at low temperatures.

In this research, it is recommended that pioneering studies be carried out contributing to the synthesis and use of new energy carriers superior in hydrogen content, conversion efficiency, and safety to organic hydrides and ammonium, on which research is already under way. However, research on these existing energy carriers can be taken up in this research area if it covers original technology based on new ideas, with different methods for synthesis, use, storage and transport than those assumed up to now.

Research Supervisor's Policy on Call for Application, Selection, and Management of the Research Area

The energy problems facing Japan need to be approached from a long-term vision, with a key issue being how to develop renewable energy into major energy sources toward finding the ultimate solution to these problems. Large-scale introduction of renewable energy from natural phenomena such as sunlight and wind, however, will require overcoming essential obstacles, including the distance of the energy production sites from consumer locations, the large seasonal and time-of-day fluctuations in their output, and the misalignment of electric power demand and supply peaks.

One possible measure for solving these issues peculiar to renewable energy would be to convert the electricity and heat produced by renewable energy to an energy storage medium (energy carrier) that contains hydrogen, safely transport and store this energy, and convert it back from the carrier to electricity or motive power for use as needed at consumer sites. Storage batteries are also being looked to for this kind of purpose; but the above energy carriers have advantages, deriving from their chemical nature, that are attracting notice. For example, they can store energy in the form of chemicals at higher density than storage batteries, are lighter and can be transported over long distances, and can store energy for long periods while adding or extracting energy at any time. Since the various energy carrier candidates differ in storage density, stability over time, ease of manufacture and use, and difficulty of introduction, a choice will likely be necessary based on the purpose and place of use. Among the chemical substances being considered for use as energy carriers, those believed promising include organic hydrides, such as methylcyclohexane, and ammonia. It will be necessary to clarify the superiority of each energy carrier substance in manufacturing hydrogen from renewable energy, converting it to an energy carrier, storing and transporting it, and using it as electrical or combustion energy, and then to select and design the optimal system.

The Ministry of Education, Culture, Sports, Science and Technology and the Ministry of Economy, Trade and Industry have decided to work together in addressing these issues concerning the manufacture, storage, and use of energy carriers. In an ALCA (Advanced Low Carbon Technology Research and Development Program) project carried out as part of this cooperation, ammonia and organic hydrides were selected as the most promising energy carriers at present; and the decision was made to focus development on the catalytic materials, electrochemical devices, and separation technology enabling the manufacture and use of these two kinds of energy carriers, including hydrogen production. This area is still far from being developed, however, as new manufacturing methods for hydrogen, ammonia, and organic hydrides, as well as two-way conversion between electrochemical substances and energy, use of heat and other energy, new use techniques taking advantage of their chemical properties, and LCA analysis are not even at the stage where they can be considered systematically with a view to the future; and there are many innovative and effective methods that have not been proposed or evaluated.

Given these circumstances, this research area will apply to other energy carriers in addition to organic hydrides and ammonia, providing a framework for implementing fundamental and core research and development from the individual standpoints of electrochemistry, catalytic chemistry, materials science, and process engineering, with the objective of discovering seeds and utilizing the results in future energy systems that use energy carriers. In order to achieve that objective, the project will be carried out as both CREST (team) and PRESTO (individual) types, with the expectation of obtaining both close collaboration among researchers in each of the above fields and the results of having individual researchers take on ambitious themes with their own original ideas.

This research area assumes a series of processes by which low-cost and highly efficient energy carriers are manufactured from the heat or electricity of renewable energy, either directly or by way of hydrogen generation, and the energy is extracted without loss at sites where it is consumed. In the FY2013 call for research proposals, the expectation is that innovative and challenging proposals will be made covering these processes in whole or in part. Other possible studies in this area include those that propose and evaluate safety in the overall processes of manufacturing and using energy carriers, and methods for their storage and transport, as well as evaluations from an LCA standpoint such as classification of energy carriers by their purpose for use, for the sake of total system acceptance. In addition, proposals of new energy carriers that do not currently have high recognition as energy carriers but that can be manufactured and used with high efficiency are also welcome. These proposals will need to do more than simply appeal to scholarly interest in reactions involving hydrogen, by including also explanations of such matters as the superiority and potential capability of energy carriers and scenarios for their introduction.

On the other hand, studies on use of renewable energy from biomass or biofuel, hydrogen manufacturing or artificial photosynthesis from photocatalysts, high-efficiency use of fossil fuels, or use of hydrogen produced as a byproduct of industrial processes are outside the scope of the call for proposals in this research area, since these topics have already been taken up vigorously in multiple other projects. Since the institutional structure for handling of energy carriers has not yet been established clearly, in the course of implementing the CREST and PRESTO research areas, focus items will be chosen at the interim assessment stage and decisions will be made on strengthening these and on such matters as policy development. For this reason, at the start of this research area, proposals will be called for with an upper limit of 200 million yen as the total research fund for CREST research, enabling adoption of as many versatile research themes as possible.

While the aim will be for common problem-solving in CREST and PRESTO, the respective features of each program will be drawn on while carrying out unified administration of the two and providing many opportunities for exchange of views and information between them. The CREST program will be carried out as team research under a team leader, with multifaceted strategic studies on innovative methods for manufacture and use of specific energy carriers; while proposals called for in the PRESTO program will be individually conducted seminal studies with the potential for playing an important role in future energy carrier utilization systems, even if their feasibility is uncertain at the present time. In the course of carrying out projects in this research area, liaison between the CREST research teams and PRESTO researchers as well as with other research areas is to be actively promoted. Moreover, since this research area is complementary to the ALCA project noted above, which places greater emphasis on feasibility, it will be carried out while exchanging information regularly with the Ministry of Economy, Trade and Industry project, which is mainly concerned with hydrogen production technology, hydrogen peripheral technologies, and energy carrier safety evaluation.

Innovative and creative proposals will be called for concerning core technologies for the manufacture and use of energy carriers, to be carried out from a long-term view.

Research Area in the Strategic Object:

Creation of innovative core technologies by merging material technology, device technology, and nano-system optimization technology toward the realization of information devices with ultra-low power consumption and multiple functions

4.1.2 "Innovative nano-electronics through interdisciplinary collaboration among material, device and system layers" <CREST＆PRESTO >

Research Supervisor: Takayasu Sakurai
(Professor, Institute of Industrial Science, The University of Tokyo)
Deputy Research Supervisor: Naoki Yokoyama
(Fellow, FUJITSU LABORATORIES LTD.)

Outline of Research Area

This research area aims to implement research and development to drastically improve the energy efficiency of information processing, enable the production of new functions, and present paths to truly commercialize the outcomes of such research and development and lead them to innovations by coordinating and integrating researches on materials, electronic devices, and system optimization.

Production of innovative basic technologies is necessary for achieving drastically better energy efficiency of information processing and providing new functions which are the goals of this research area rather than solely relying on the advancement of microfabrication. Such technologies are essential for improving performances and enhancing the Internet and information devices and useful for producing new applications and services, which are more closely related to the physical world by heavily using sensors and actuators.

The following nano-electronics materials and devices are considered specific research fields: devices made from new functional materials,new semiconductors and new insulators, such as carbons, composite materials, and single monoatomic layer materials; quantum effect devices; low-leakage devices; new structural logic devices; new memory devices; devices for power management; new electronic devices for physical world interfaces; and non-Boolean Algebra processing devices. Yet, this research area pursues new functional materials and devices based on new materials, new principles, and new structures rather than being limited to materials and devices listed above. Meanwhile, applications, systems, architectures, and circuits technologies must be coordinated or integrated based on synergy to lead them to true innovations. Thus, this research area actively promotes the optimization of selection and directions of materialtechnologies and device technologies by aiming for practical applications. This research area aims to produce fundamental technologies for innovative information devices through reinforcement and acceleration of such interdisciplinary scientific technologies.

Research Supervisor's Policy on Call for Application, Selection, and Management of the Research Area

1) Integration between technological layers

This CREST research area is aiming to produce fundamental technologies for innovative information processing devices by integrating technological layers, such as nano-materials, nano-devices, design and circuits, architecture, and systems. Researchers from different layers are encouraged to cooperate with each other and produce outcomes to promote organic cooperation and integration between layers. PIs (Principal Investigators) may specialize in any layer, but they must form a group with joint researchers specializing in different layers and make proposals with them. A group must consist of a researcher specializing in nano-material layer or nano-device layer. Rather than just having researchers from different layers, a group must clarify that researchers are organically connected and producing synergistic effects. Researchers belonging in different layers may result in variations in timing, such as that researchers in upper-level technical layers cannot conduct research unless research outcomes in layers closer to foundations are produced first. Groups must make sure that concurrent researches are conducted by making arrangements, such as using modeling and simulations and gradually expanding research. Research proposals are expected to clearly describe these arrangements.

The PRESTO research area accepts proposals for individual layers of nano-materials and nano-devices. Among them, this program encourages proposals that mention designs/circuits and systems. This program also accepts proposals for individual layers of designs/circuits, architectures, and systems. Proposals in which nano-materials and nano-devices are present to realize such layers or ones that present high possibility of obtaining them in the near future are encouraged.

2) Goals

Silicon devices have been supporting information-oriented society as the foundation, but microfabrication and integration that are the sources of the progress are approaching the limits. Given such circumstances, rather than only relying on the progress of microfabrication, this program is aiming to produce fundamental technologies for innovative nano-electronics so that nano-electronics will continue to improve the foundation of information-oriented society and become a solution to domestic and global social problems, such as energy and environmental problems, problem of an aging society with a declining birthrate, realization of healthy and safe society, and aging infrastructures. This program also aims to improve the international competitiveness of industries through such efforts. Drastic improvement of energy efficiency of information processing and production of new functions are considered essential for achieving these goals. Improvement of energy efficiency of information processing means that a certain energy (powerx time) becomes capable of processing more information. Improving energy efficiency, increasing speed, and increasing functions are possibly effective means to achieve this goal. Proposals are expected to describe quantitative reasons for drastically improving energy efficiency. This program applies a broad interpretation of information processing, and accumulation and transmission of information are included in information processing. Concerning the realization of new functions, proposals are expected to quantitatively and clearly describe how improvements in the foundation of information processing and electronics, such as smart houses, traffic, next-generation automobiles, robots, and human interfaces, will broadly contribute to the lives of people and how the outcomes of proposed research will be used in specific fields and what types of effects they will bring. These descriptions must be accompanied by reasons.

3) Innovation strategy

It is important to mention applications to start practical uses of scientific technologies that lead to true innovation. Therefore, proposals should describe how produced fundamental technologies would result in strengthening specific applications and services based on reasons. In the final phase of a research, researchers are expected to give demonstrations using actual systems so that researchers will carefully explore and select contents of research while constantly being aware of practical uses and innovations. CREST research proposals require demonstrations using actual devices for presenting outcomes and quantitative and clear descriptions of research prospects. This program strongly encourages participation by industries to accelerate innovations. Use of TIA (Tsukuba Innovation Arena) is also encouraged as infrastructures for conducting joint researches between industries and academia. While PRESTO research proposals do not require demonstrations using practical devices, this program encourages research that can provide demonstrations within two years from the completion of the PRESTO program. This research area promotes an integrated operation between CREST and PRESTO and encourages PRESTO research results to be extended in CREST program for demonstration.

Research Area in the Strategic Object:

Creation of new functional materials by means of technology for controlling spaces and gaps in advanced materials in order to realize selective material storage, transport, chemical separation, and conversion, etc.

4.1.3 "Creation of Innovative Functional Materials with Advanced Properties by Hyper-nano-space Design" <CREST>
Research Supervisor: Tohru Setoyama (Executive Officer Fellow, Mitsubishi Chemical Corporation)

<u>Outline of Research Area</u>

This research area focuses on finding solutions to some of the most important challenges facing human civilization in the 21st century, such as those related to the environment, resources (feed-stocks), energy, medicine, and health, through the development of the technology of hyper-nano-space design to create innovative materials with cutting-edge functions that are not realizable with conventional existing technology.

In particular, the objective of our research is to realize the expression of highly desirable and advanced functions and properties in materials used for the storage, transportation, and separation of energy and chemical resources, catalytic conversion, highly efficient energy conversion, mitigation and removal of environmental contaminants, procurement of potable water, as well as in materials used for medical care and health purposes. Hyper-nano-space design is the sophisticated design and control of the space-and-gap architecture that is formed from the positioning and linking of atoms and molecules; in other words, it is the design and control of the dimension, shape, size, composition, regularity, crystallinity, and interface of materials to create sufficiently differentiated revolutionary functional materials.

Our research subjects include not only widely recognized space-and-gap-controlled materials such as nano-porous materials, meso-porous materials, materials with layered or cage structures, nano-tubes, macro-molecules, supermolecules, biomolecules, and structural materials, but also materials in which the space-and-gap architecture has the potential to be the venue for functional expression. With a team that brings together knowledge across diverse disciplines such as chemistry, physics, biology, engineering, computational science, and measurement technology, we encourage going beyond just fundamental research and setting our sights on realizing functions and properties that can lead to the most advanced materials and products in the world, with possibilities for industrial applications for use in Japan. That is, we want to contribute to Japan's Renaissance in the 21st century by means of our scientific aspect—hyper-nano-space design.

<u>Research Supervisor's Policy on Call for Application, Selection, and Management of the Research Area</u>

The 21st century has so far been a time of drastic change in the global environment. Japan must thus adapt to such environmental changes by applying suitable strategies and leaving risks behind to the rest of the world. Changes are especially notable in the areas of economic affairs and the environment, with the economic rise of China and other emerging nations, climate changes on a global scale (so-called global warming), nuclear power policy after the Fukushima Daiichi power station incident, and the rapid spread of unconventional fossil fuel resources such as shale gas. If these issues are not addressed with policies and strategies that are appropriate for future society, the results may be irremediable. However, for Japan, which aims to be a leader in science and technology, the situation can be seen as a favorable opportunity for delivering distinctive technologies and products stemming from leading-edge science to the world.

Under these situations, hyper-nano-space design can be expected to have a wide range of uses and applications, especially in the efficient use of energy and the reduction of negative impacts on the environment.

As mentioned above, subjects in this research area cover not only existing space-and-gap-controlled materials but also various substances and materials in which space-and-gap architecture can contribute as a main factor to the expression of advanced functions and properties. Because the degree of design and control of material structure is already at a rather high level, we expect this research to bring about even higher properties and functional expressions. In addition, one material hardly ever expresses a function sufficiently on its own; in most cases, excellent functions are expressed in combination with other materials or by means of material interface design. Considering this perspective, the starting point of this research area lies in the envisioned properties and functions that can only be dreamed of with current technology; from this, we anticipate proposals to be made for new materials that meet the envisioned characteristics by means of hyper-nano-space design, as well as the mechanism behind the expression of functions and properties to be elucidated and predicted. Given that, in many cases, sufficient differentiation cannot be achieved by one outstanding property or function and the significance of composite spatial structures cannot be sufficiently emphasized in order for Japan to deliver unrivaled cutting-edge materials to the world. In this aspect, the theoretical understanding and design of composite by hyper-nano-space design will be exceedingly important.

The creation of a new industry requires foreseeing the intrinsic desires of society 10–20 years in future, that is, not needs in the narrow sense but wants. In this research, the following are reference examples of such wants:

- Invention of materials for the efficient separation, storage, and transport of energy raw materials, chemical raw materials, etc., and for catalytic conversion and efficient separation of these materials to realize valuable chemicals.
- Invention of materials necessary for reduction or removal of environmental contaminants and for procuring potable water.
- Invention of energy conversion materials and structural materials for efficient energy use and energy conservation.
- Creation of new areas in the life sciences field.

Many other wants surely exist in addition to these. We welcome the proposal of unforeseen wants and corresponding issues and solutions from the standpoint of hyper-nano-space design. In approaching the research issues, it is desirable in principle to cooperate with corporations on each issue in order to ensure that the requirements for industrial application are sufficiently discussed. The time required for investigation in this research area will be regarded as the incubation period for establishing a foothold for the birth of major new industries. Proposed hyper-nano-space design should be an original concept, and hence stimulating fusion and synergetic effects through multi-disciplinary interaction is essential. Therefore, we hope for research proposals to be made from the viewpoint of many different disciplines including chemistry, physics, biology, and engineering, while taking advantage of cutting-edge computational science and measurement technologies for which Japan is highly reputed. In addition, there must be strong awareness for cooperation with researchers from the PRESTO (Sakigake) program, keeping in mind the possibility for further collaboration between CREST and PRESTO (Sakigake), especially in areas where major advances have been made by their efforts.

4.1.4 "Hyper-nano-space design toward innovative functionality"<PRESTO>

Research Supervisor: Kazuyuki Kuroda

(Professor, Faculty of Science and Engineering, Waseda University)

Outline of Research Area

This research area aims to create novel, epoch-making materials that address societal needs in areas such as the environment, energy, medicine, and health. To achieve this, we aim to establish a hyper-nano-space design technology that comprises high-level design and control of spaces and gaps within materials and achieves an innovative functionality that transcends the functionality obtained with conventional porous materials.

Research themes promoted in this research area are expected to be pioneering and original, and to probe how hyper-nano-space design and control can lead to novel innovative functions. Some expected functional properties are energy conversion, chemical conversion, chemicals transfer and separation, molecular recognition, medical use, structural materials, electronic devices, etc.

In addition, this research area aims to promote challenging approaches that contemplate future processing and industrialization. The approaches must be based on a wide viewpoint and must combine chemical synthesis with cutting-edge measuring techniques and calculations in order to clear the functional properties of the hyper-nano-spaces.

This research area will promote challenging and enthusiastic research aiming to lead the world toward new frontiers in materials research and development.

Research Supervisor's Policy on Call for Application, Selection, and Management of the Research Area

The creation of new materials deeply impacts the diverse needs of human living, such as energy, the environment, medicine, and health. New materials have the power to create and lead a new epoch. For example, zeolite materials have shown great academic development and are also widely used in industry. Mesoporous materials are not only utilized in application research but also have greatly contributed to the development of adsorption science. Porous coordination polymers (PCPs)/metal organic frameworks（MOFs） go far beyond the category of metal complex chemistry, and have a branch of materials science. It can be said that owing to their great potential for industrial application, PCP/MOF materials are in the midst of popular R&D competition. Japan has been leading the development of porous materials since many years. The challenge is to strengthen and elevate this leadership to an overwhelming level.

There are numerous hyper-nano-space materials having various compositions and structures, but this research area will position the creation of new materials as the most important aspect. New materials have the power to create a new epoch. New epoch-making materials are the aim of this research area, in the same way as high-temperature superconductors, carbon nanotubes, and mesoporous materials emerged in the late 1980s.

To achieve this, we aim to design new groups of materials on the basis of innovative ideas and concepts, which cannot be found in the extension of existing materials. Diversified views or approaches are required to achieve a drastic development, e.g., in addition to chemical approaches such as inorganic and organic synthetic chemistry, approaches from the final function desired, approaches from the physical properties of the elements, and approaches from other diversified views in engineering, biological, and medical/pharmaceutical must be included. In this research area, the collaboration and fusion of diverse fields will be actively promoted.

To design new material groups, it is essential to deepen and develop technologies such as simulation and structural analysis. Cutting-edge evaluation and measurement techniques make it possible to precisely and remarkably evaluate hyper-nano-spaces and understand their active behavior. An essential element in this research area is being able to manage these techniques. In addition, it is expected to achieve progress regarding synergy with computational science, i.e., prediction of the function and properties in new materials, and analysis of the mechanisms.

This research area will cover material groups that transcend the expectations of conventional porous materials. The research proposals did not focus only on functions attributed to pore diameter or surface structures, but they also welcomed the functions that challenged the realization of new ideas by means of hyper-nano-space design (i.e., the high-level design and control of spaces within materials) under the common phrase of "spaces working as spots for the emergence of new functions." Thus, this research area aims to truly investigate the creation of materials deeply related to various societal needs, including the environment, energy, medicine, and health. Example of societal needs are technologies for chemical transfer and conversion; technologies that permit chemical separation and conversion; highly efficient and economical separation membranes; drug-delivery systems; molecular imaging; ultra-light and extremely strong structural materials; energy conversion materials such as solar fuels, secondary batteries, and thermoelectric conversion materials; electronic materials such as semiconductors and superconductors; molecular recognition materials such as sensors and biocompatible materials, medical use, structural materials, and electronic devices.

Creative ideas are welcome in order to utilize the hyper-nano-spaces as spots toward the creation of innovative functions, making hyper-nano-spaces different from conventional porous materials. However, the research proposal cannot be a fictional story. The applicant must show the concepts, insights, and theoretical considerations behind the proposal and also show supportive information on the feasibility of the research plan.

Ambitious proposals in wide fields of chemistry, engineering, pharmacy, physics, biology, and biomedicine are welcome. Please be aware that the proposal must be based on novel ideas, and also consider the following points:

1. It is a proposal where the hyper-nano-space is expected to play an essential role.
2. The purpose of the design of the hyper-nano-space must be clear.
3. In addition to the creation of new functions, the research proposal must analyze what are the advantages of the new materials and how advantageous the new material is in comparison with the existing or competing materials.

Because it is understandable that different research themes will show different degrees of expectance, it is expected that the above points will be investigated and reflected in the proposal.

There are numerous parameters related to hyper-nano-space design. The applicant must examine these parameters extremely well, thinking deeply as to where is the essence of the function generated by the hyper-nano-space, and reflect into creative proposals founded in the applicant's original views. Research proposals leading to a big outcome and the willingness to open a new era and tackle the world are expected. Research proposals coming from applicants who have been developing research in the field of porous materials should be based on original approaches and new concepts that are not found in the extension of conventional research. Creative and challenging research proposals that are able to produce a new stream in this field are strongly encouraged.

It is expected that the applicant strongly desires that "This is the theme that I should and want to develop now." Moreover, preliminary investigations should support the viability of the research proposal. Ambitious research proposals that lead to a new frontier in science are welcome. In addition, depending on the progress of the research theme, cooperation with CREST- and PRESTO-related research areas will be considered.

Research Area in the Strategic Object:

Creation of theory, mathematical model, and fundamental technology to establish a cooperative distributed energy management system, which enables the optimization of demand and supply for various energies including renewable energy

4.1.5 “Creation of fundamental theory and technology to establish a cooperative distributed energy management system and integration of technologies across broad disciplines toward social application” <CREST>

Research Supervisor: Masayuki Fujita

(Professor, Graduate School of Engineering, Tokyo Institute of Technology)

Outline of Research Area

The goal of this research area is to create theory, mathematical models and fundamental technology for optimal control of energy demand and supply in energy management systems linking customers and a variety of energy sources including renewable energy.

Specifically, this research area invites proposals on theory and basic technologies to realize cooperative control and situation awareness of spatially distributed energy demand and supply through mutual and real-time interactions of both energies and information.

It is also promoted to create theory and basic technologies integrating human behavior and social rationality in order to lead the selfish decision making of consumers and suppliers to social advantages in overall energy management system.

Moreover, it is also encouraged to create theory and basic technologies to grasp the status of, estimate, and forecast demand and supply of renewable energy by learning from satellite data, regional meteorological observations, geographical information, and past supply-demand records.

This research area also aims at combining different research fields such as system science, control, information, communication, energy and social science in view of the exit of establishing a cooperative distributed energy management system.

Research Supervisor’s Policy on Call for Application, Selection, and Management of the Research Area

It is necessary for persistent future growth of Japan to realize stable supply and acquisition of energy while aiming at low carbon society.

In addition, the full-scale introduction of renewable energies to the power system has become an urgent policy issue due to the changes in situations after the Great East Japan Earthquake.

For these purposes, it is aspired to establish a cooperative distributed energy management system achieving total optimization and control of energy supply and demand by operating synchronously a variety of spatially distributed energy sources such as mega solar power plants and wind farms according to the utility forms.

This research area is aiming to develop theory and basic technologies involved with the establishment of a cooperative distributed energy management system and to set a course toward its actual application in society by integrating the research and development outcomes.

The outcomes generated through the research area are expected to contribute to establishing innovative infrastructures solving the social energy agenda.

It is thus important to promote researches that precisely capture social needs with a vision of energy systems based on solid science and technology.

It is also inevitable to examine how to realize coordination between distributed energy systems with deep integrations of renewable energies and conventional power systems, how to ensure stability of the energy system including in cases of disasters and how to evaluate social rationality such as the introduction cost.

Universal and fundamental theories and technologies that can respond to various needs are also to be established because the requirements for energy systems dynamically change depending on social situations of a given time.

These scientific examinations require the participation of researchers not in the fields which have been, so far, the main participants in the establishment of energy systems in Japan. The research area hence tackles the energy agenda by gathering researchers from a variety of research fields such as system science, control, information, communication, social science in addition to the conventional fields such as energy.

Against such backgrounds, the research area sets up a team-based research program CREST and makes maximal use of the advantage of CREST so as to realize the true coordination among different research fields and to help researchers perform to the best of his potential toward solutions to the social challenges.

Specifically, this year's recruitment calls for small-scale teams addressing research and development of technology in a variety of individual fields. The research period of all projects is limited to 1.5 years until the end of March, 2015.

During the 1.5 years, the research area sets up a place to openly discuss the image of the ideal energy system of Japan including research communities outside of the area and to deepen mutual understandings.

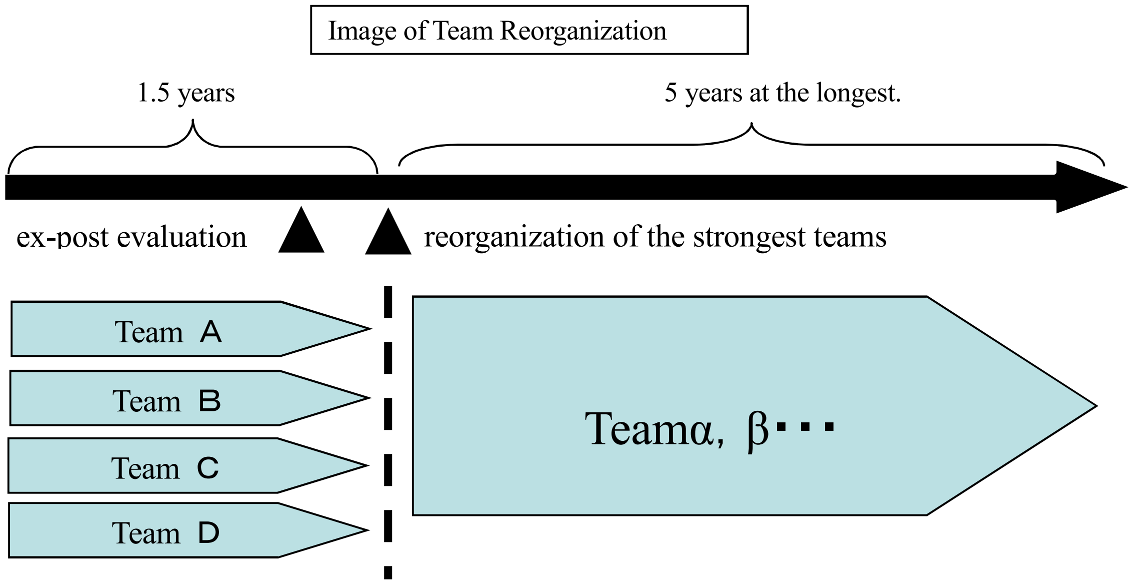
For this reason, the research area strongly expects aggressive applications from young researches and small teams capable of not only providing outstanding researches but also in-depth discussions beyond the research fields and fully utilizing researchers' brains.

It is also expected to share the strategy of this research area, to develop the strategy through the thorough discussions and to feed it back into the researches.

After the efforts, research teams will be reorganized on April 2015 fusing different teams selected in FY2012 and FY2013 open recruitment so that the new groups become the strongest teams consisting of members who have shared concrete images to be targeted and created mutual understandings beyond specialized fields through the individual research works in the first 1.5 years.

After the reorganization, the research area again aims at promoting research works with a strong impact all over the world, producing new scientific principles and academic fields and creating novel values. In addition, the research area seeks possibility of coordination with associated projects.

The scale of the new research teams after the reorganization is assumed to be larger than initial projects. The research period will be 5years until March 2020 at the longest. Therefore, this year's recruitment calls for proposals considering the reorganization. (e.g., it explains about the collaboration with accepted teams in FY2012).



In this open recruitment, the research area invites proposals in individual research fields on Approach 1-4 in the Strategic Target (See "Call for Proposals") such as: control technologies, optimization technologies, and mathematical model and simulation technologies to establish and operate diversified complex systems; information communication technologies for mutual and real-time processing of both energies and information among demand-side and supply-side subsystems; sensor network technologies and data mining technologies for high-speed processing and analysis of obtained data; network theories for analyzing structures and features of complex systems; global environmental measurement and forecasting technologies to forecast natural energies; forecasting of energy consumption which takes into account of human behavior.

It is also encouraged for researchers of system science to propose innovative theory and basic technologies to integrate these individual approaches as a system.

The approaches of this research area differ from the system of the traditional CREST but it is strongly hoped that researchers with flexibility and strong spirits tackle the social challenges via the power of "science and technology".

Important Notice:

- This open recruitment calls for small-scale teams (The average annual budget size of the project shall be less than 60 million yen and hence the total amount for 1.5 years should be less than 90 million yen). Note that any projects, whose annual budget exceeds 60 million yen, will be never accepted.
- The period of the proposed project shall be 1.5 years until the end of March 2015.
- The projects of the new groups organized on April 2015 will continue until March 2020 at the longest and can be the project type whose annual budget exceeds 60 million yen.
- It is not guaranteed for all accepted teams to participate in the strongest group which will be organized on April 2015. All the projects will be evaluated in the latter half of 2014 and some teams may leave the new groups depending on the evaluation result and the concept of the team organization.

Research Area in the Strategic Object:
Establishment of molecular technology, which is the free control of molecules to bring innovation to environmental and energy materials, electronic materials, and health and medical materials

4.1.6 "Establishment of Molecular Technology towards the Creation of New Functions" <CREST>

Research Supervisor: Hisashi Yamamoto
(Professor, Chubu University / Professor Emeritus, Chicago University)

Outline of Research Area

"Molecular technology" is a series of technologies that enable us to qualitatively change existing science and technology through purposefully designing and synthesizing molecules and creating the physical, chemical, and biological functions of materials at a molecular level. The creation of new physical properties at the molecular level is the ultimate form of material synthesis in which the best and most suitable molecules selected from an infinite number are freely designed and synthesized by controlling molecular shape/structure, electronic state, aggregate/composite, and transport/migration with the collaborative use of precision synthesis techniques and theoretical and calculation sciences. With this, we can expect the creation of ultimate new intelligent materials that truly are competitive industrially.

In this research area, we shall set as our final goal the establishment of a molecular technology that can lead to the creation of unique new intelligent materials, devices, and processes that are innovative as well as precise and unachievable with a mere extension of existing science and technology, which remains at a conventional molecular library, by deepening our exploration of various problems needing to be addressed down to a molecular level and by designing / synthesizing / manipulating / controlling / aggregating those molecules that have desirable functions.

To bring more universality into our research and development in this molecular technology, we shall consider those bottleneck application problems that have not been solved by knowledge of such individual disciples as chemistry, physics, and biology as common and shared ones, and make an effort to build a unique technology system by overcoming those problems through an interdisciplinary approach.

Based on the common base of "molecular technology," those researchers, who have been actively engaging in their respective projects of wide-ranging application and in special fields with little contact with other fields, shall come together to review each other's research and technology and bring in new perspectives. Ambitious and challenging research topics shall be pursued by those cross-sectional team members who are strongly aware of their mission of making a breakthrough in the development of new intelligent materials to meet wider social needs.

Research Supervisor's Policy on Call for Application, Selection, and Management of the Research Area

"Molecular technology" is a series of technologies that enable us to qualitatively change existing science and technology through purposefully designing and synthesizing molecules and creating physical, chemical, and biological functions of materials at a molecular level. "Molecular science," which may be more familiar, is a discipline whose objectives are to analyze the structures and physical properties of molecules and their aggregates at a molecular level and to identify their chemical reactions, molecular interactions, and nature in terms of both theories and experiments. Knowledge and understanding derived from this molecular science form the basis for building "molecular technology." In other words, molecular technology, in contrast with existing technologies, is a leading technology that will contribute to the general welfare of all people in the world as well as become sources of our national strength by allowing us to create analytically desired functions and physical properties at a fundamental and molecular level that could lead to the emergence of new industries. In this research area, we carry out comprehensive research and development in “molecular technology.”

Today, we observe that materials of various parts and components are gradually shifting from existing semiconductors and metals to so-called “soft materials,” which are molecular materials. This suggests that “soft materials” and their enabling “molecular technology” can provide solutions to those problems that all humanity is facing, including lower environmental burdens, an adjustment to dwindling natural resources, and better affinity with ecological systems. This research area focuses on the building of “molecular technology” that will enable us to freely design molecules that should produce innovations in materials for environment/energy, electronics, and health/medical equipment. To generate innovative results relating to “Life Innovation” and “Green Innovation,” in other words, we aim at accelerating the infusion of individual projects and different disciplines by establishing a solid base for “molecular technology” which can be deployed into various fields, separately from research and development projects for individual applications.

“Molecular technology” consists of the following six elemental technologies: 1) “molecular technology for design and creation” that will allow us to freely design and create new functional intelligent materials with the collaborative use of precision synthesis techniques and theoretical and calculation sciences; 2) “molecular technology for shape and structure controls” that will allow us to create new functions through strictly controlling molecular shapes and structures; 3) “molecular technology for conversions and processes” that will allow us to develop new catalysts and systems based on structural designing at a molecular level; 4) “molecular technology for electronic state controls” that will allow us to freely control the electronic state of molecules; 5) “molecular technology for aggregate and composite controls” relating to the form/function analysis and chemical controls of molecular aggregates and composites; and 6) “molecular technology for transport and migration controls” relating to the transport of molecules and ions, such as improvement in speed and selectivity of transporting molecules and ions via membranes. Some of the applications, which are based on molecular technology consisting of these elemental technologies, include electronic equipment incorporating soft materials, solar cell films featuring super-low power consumption and resource recycling, and medical treatments utilizing drug-delivery systems. The scope of applications of molecular technology is widely expanding now.

This research area aims at building a seamless bridge between anticipated needs in a distant future and the potential of molecular technology. Thus each applicant is asked to, in accordance with social needs, set his/her eyes on a “dream goal,” which cannot be achieved with the current level of technology, set forth a novel proposal, such as solar cells that can absorb infrared rays, and the “Sakichi battery,” which was originally proposed more than a century ago, develop a new plan in his/her own research theme that differs from a mere extension of existing researches, and come up with an “image story” using clear and original molecular technology to realize the plan. Furthermore, each applicant is asked to pursue what must be done, instead of doing merely what can be done, advance research so that “molecular technology” can become our country’s national pride, new value-added industries can be created, and sustainable societies beneficial to the survival of human kind can be built.

To achieve this aim, in conducting this research area, we plan to aggressively adopt a dynamic form of operations to promote interdisciplinary research, including not only close working relations and joint ventures among CREST research teams but also holding workshops and symposiums intended to maximize synergies with those researchers from “PRESTO” projects. We welcome challenging proposals that can become achievable only through collaboration. While we particularly emphasize close working relationships with those companies that can provide us with concrete foreseen needs in a distant future as well as concrete field needs, we believe it is, in principle, desirable to form one-company-for-one-project collaborations. Even if it is difficult to form such collaborations with companies by the time of the proposal submission, we expect the proposal should be based on a research scenario that assumes collaborations with companies after its start-up.

The present research area began in 2012 and has been rewarding in the field of medicinal chemistry, including DDS projects, molecular magnetics, and solution plasma. This year, in addition to the areas of materials and drugs, we are expecting applications in the areas of chemical reactions, catalysts, energy, calculation sciences, and so on, which we were unable to support last year because of budget limitations. The first year project was set up for applications with a budget of up to 500 million yen/5 years, but this year, we will be accepting those with a budget of up to 300 million yen/5 years.

The organization of the projects should be highly effective for achieving the proposed research aims. Applications that deviate from the main aim of the research will not be likely to receive positive decisions. Needless to say, applications by a single research group will be considered. Furthermore, is necessary to pursue social benefits as the aim of the project, but it is much more important that the applicant has a distinct scientific idea that relates to molecular engineering. Simple “smart” applications with a genuinely powerful chemical approach are encouraged.

Soon, we will upload a “list of evolutionary molecular engineering topics” on our homepage. Please check the list when you prepare your application.

4.1.7 “Molecular technology and creation of new functions” <PRESTO>

Research Supervisor: Takashi Kato (Professor, School of Engineering, The University of Tokyo)

Outline of Research Area

The purposes of this research area are to cultivate and establish “Molecular Technology” that precisely controls the functions and behaviors of molecules, strongly promote further development and new expansion of studies and industrial capabilities of molecular materials in Japan, and contribute to the sustainable development of society in order to produce molecular-based new materials, new devices, and new processes. This research area targets innovative, challenging, and unique molecular technologies concerning technologies for designing, synthesizing, and altering molecular structures to produce functions of clearly defined molecular materials, technologies to create and control integrated or combined structures of molecules, technologies to develop molecular functions, and technologies to produce devices and processes. The field of study includes studies of fundamental technologies of molecular materials, such as studies founded on common bases, including challenging approaches that take into account the technical flow of design → conversion →assembly and complexation →development of functions → production of materials → production of devices and processes, as well as research that integrates molecular designs and conversions.

Specifically, advanced, unique, and fundamental studies that contribute to the production of molecular technologies are targeted as important studies. Such studies include technologies to design, synthesize, and convert molecules with a clear goal of producing functions; technologies to construct orders of one-dimensional, two-dimensional, and three-dimensional molecular assemblies and complexes;
technologies to build energy device materials that control behaviors of electrical charges and ions; studies based on comprehensive perspectives of the flow from fundamental studies for constructing environmental and medical materials that selectively transport molecules and ions using complex structures, such as artificial membranes and micelles to the process of turning them into materials; and studies on molecular measurement and analytical technologies.

Research Supervisor's Policy on Call for Application, Selection, and Management of the Research Area

Molecular materials are expected to be used for solving various problems in the world, such as the environment, resources, safety and security, and health and medical issues, as well as for the continuous advancement of mankind. This is because molecular materials are expected to be applied to the reduction of environmental burdens and the limited use of resources as well as to deliver great biological compatibility. Molecular technology that realizes these goals is the series of technologies that create molecular functions and utilize them based on scientific knowledge of physics, chemistry, biology, and mathematics for the purpose of using them to create new materials, new devices, new processes, and useful materials. The structure of this research area enables fundamental technologies that establish innovative production of materials by designing and synthesizing molecules with clear objectives, freely controlling the molecules, precisely integrating and combining the molecules, and effectively using the molecular features. Meanwhile, there is a field of study called "Molecular Science". This research area aims to study structures and properties of molecules and molecular complexes at molecular levels and to clarify chemical reactions, mutual interactions of molecules, and their principles based on theories and experiments. "Molecular Technology" creates the desired functions of molecular materials based on the knowledge and understanding gained in molecular science.

Japan is maintaining strong global competitiveness in academics and industries in the field of molecular-based functional materials. This research area will be further strengthened and expanded by building and establishing the concept of "Molecular Technology", making it one of the sources of national strength and contributing to the happiness of mankind. This research area deals with such molecular technologies and strengthens the academic structures that result in the production of new and innovative materials.

The establishment of "Molecular Technology" as an independent field of technology requires essential development of "technology for control of molecular electronic states", "technology for control of molecular shapes and structures", "technology for control of molecular assemblies and complexes", and "technology for control of transportation of molecules and ions" based on "technology for molecular design and creation" and "technology for molecular conversion and processing". It is necessary to deepen the fundamental understanding of the behaviors and characteristics of molecules and molecular complexes to construct innovative functional materials to freely achieve strategic goals aiming to create targeted functions. The behaviors of individual molecules and molecular complexes are closely related to the development of functions, but molecules are diverse and complicated. The mission of this research area is to understand their relationships and lead the understanding to the development of astounding functions. In order to complete this mission, a series of flow from designing molecules to controlling molecular assemblies and complexes is important rather than being limited to exploring one of the technologies mentioned above. Therefore, this research area welcomes proposals that also cover combinations and cooperation among different fields.

Through this open recruitment, we are expecting to receive proposals for innovative, challenging, and unique molecular technologies concerning technologies to design, synthesize, and convert molecular structures for creating clearly defined functions of molecular materials; technologies to create and control assembled and combined molecular structures; technologies to develop molecular functions; and technologies to create devices and processes. We target advanced, fundamental, and cross-boundary

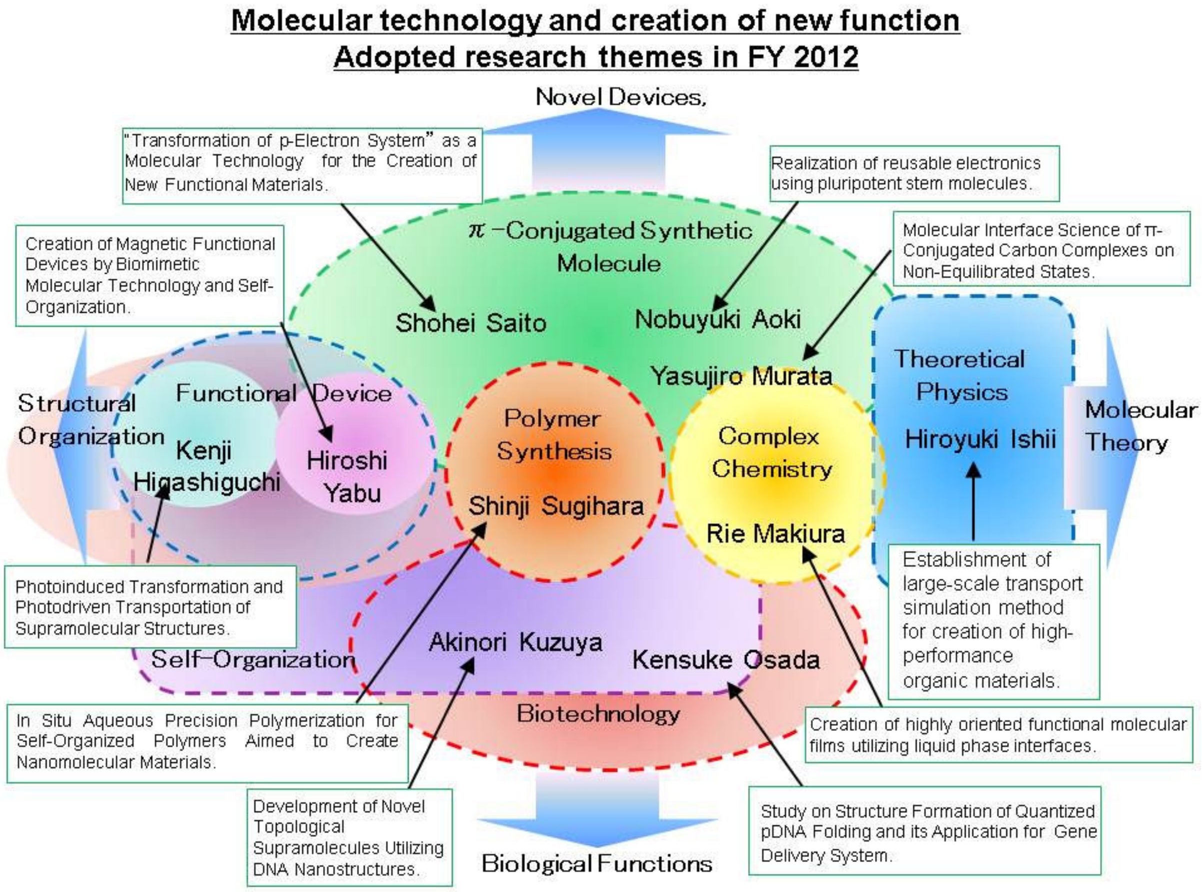
research on technologies to design, synthesize, and convert molecular structures to develop functions of molecular materials; technologies to create and control molecular assembly and complex structures using processes that require low energy and low environmental loads, such as self-assembly; technologies to develop molecular functions; and technologies to produce devices and processes. In addition, the target also includes studies, such as ones founded on common bases, including challenging approaches that take into account the technical flow described above and studies that fuse mathematical approaches, such as theories and simulations with molecular designs and alterations.

Specifically, advanced, unique, and fundamental studies that contribute to the production of molecular technologies are targeted as important studies. Such studies include technologies to design, synthesize, and convert molecules with a clear goal of producing functions; technologies to construct orders of one-dimensional, two-dimensional, and three-dimensional molecular assemblies and complexes that cover from nano-level to micro and macro levels; technologies to build energy device materials that control behaviors of electrical charges and ions; studies based on comprehensive perspective of the flow from fundamental studies for constructing environmental and medical materials that selectively transport molecules and ions using complex structures, such as artificial membranes and micelles to the process of turning them into materials; and studies on molecular measurement and analytical technologies.

In terms of the research area, we are expecting applications from researchers in a wide range of fields, such as chemistry, material science, biology, engineering, electronics, systems science, physics, and mathematics. The important point is that proposals should be original, unique, and based on researchers' own ideas. The basic concept is that researchers from different fields can get together at the common platform of this research field and produce new and fundamental academic developments and become leaders of this field. We are expecting flexible ideas. Proposed research projects should be based on the autonomous activities of applicants. Yet, PRESTO (Sakigake) research may be conducted through the close cooperation among different fields if joint research among applicants or integrated research from different fields is needed for the purpose of implementing field-binding research. In such cases, please describe the autonomous aspects of the PRESTO (Sakigake) research (specialty and roles of an applicant) and types of cooperation with different fields (specialty and roles of joint researchers). Joint researchers may belong to either public agencies or private companies.

We strongly encourage cooperative studies among researchers from different fields by providing many opportunities for them to exchange information and engage in discussions so that they can share an awareness of merging different fields. In addition, joint study sessions and symposiums are provided to maintain close cooperation with relevant CREST researches. The research area aims to build and establish molecular technology structures, thereby invigorating academic sectors and industries and contributing to building human societies that keep advancing.

<<Adopted research themes in FY 2012>>



Research Area in the Strategic Object:
"To realize breakthroughs in phase-interface phenomena and create basic technologies for high-functionality interface that will result in dramatic advancements in highly-efficient energy utilization"

4.1.8 "Phase Interface Science for Highly Efficient Energy Utilization" <CREST>
Research Supervisor: Nobuhide Kasagi
(Professor Emeritus, The University of Tokyo / Principal Fellow, CRDS, JST)

-Science Approach
-Engineering Science Approach

Outline of Research Area

The primary goal of this research area is to greatly advance fundamental science and technology, which include exploration of phase-interfacial energy conversion/transport phenomena and creation of high-performance phase interfaces, in order to achieve ever more efficient energy utilization and thus to realize an enriched sustainable society.

Specifically, we take up the challenge of creating phase interfaces with significantly reduced energy losses and/or those for highly efficient energy use by deepening fundamental theory and control/optimization methodology of phase interface phenomena. To accomplish these goals, it is indispensable to establish analytical and design techniques integrating nano-, meso- and macro-scales, as well as theoretical methods for the control and optimization of phase interface structures. Furthermore, it is important that the results of such cutting edge fundamental research should be transferred and effectively applied to the design of real equipment and systems, leading to dramatically improved performance, reduced carbon emissions and lower costs.

The ultimate goal of this research area, therefore, is to elucidate energy conversion and transport mechanisms at phase interfaces in order to enable highly efficient energy use; to develop measurement, modeling and simulation methods for integrative analysis and design of phase interface phenomena at multiple scales; to establish mathematical methods for the control and optimization of phase interface structures; and to realize highly functional phase interfaces that allow for theoretically possible maximal performance in actual devices and equipment. To meet these goals, we encourage integrated challenges that go beyond the bounds of existing scientific disciplines and combine the knowledge gained in different fields.

Research Supervisor's Policy on Call for Application, Selection, and Management of the Research Area

To overcome global problems, such as climate change and resource depletion, and to build an enriched sustainable society, we should, based on the assessment of target technologies in terms of how much contribution they potentially offer, raise their energy utilization efficiency to their limits and seek completely new alternative energy technologies. Improving both energy utilization and harvesting efficiencies has become ever more important research and development goals.

Devices and equipment related to energy always contain boundaries with components of a variety of materials in the solid, liquid, and gaseous states (phase interfaces), and many rely upon the exploitation of mechanical, chemical, or electromagnetic phenomena that occur at such boundaries. The current performance of such energy-related systems, however, is far inferior to their theoretical performance limits. This is due to irreversible losses in energy conversion, transport, and storage processes, and in many cases, these losses are associated with phase interface phenomena. Therefore, achieving a substantial reduction in such irreversible losses is a fundamentally important R&D goal for energy saving, better efficiency, and utilization of new energy resources.

Examples of outstanding challenges include improvement of thermal energy conversion efficiency through control of complex turbulence and boiling; reduction of friction loss in transport vehicles; investigation of the electrochemical reaction mechanisms on the electrode surfaces in fuel cells and secondary batteries as well as the optimization of materials and morphology at their phase interfaces; analysis and optimization of the fundamental processes of electric power generation and fuel production from solar energy; renovation of heat pumps through advanced technologies for heat/mass transfer and phase separation; detailed analysis of separation membrane structures and optimizing a pore diameter and phase interface structures; and efficiency improvement of power semiconductor devise through phase interface control.

An effective step toward solving these problems should be to further our understanding of basic principles related to phase interface phenomena and to use the newly gained knowledge in the design and demonstration of ideal surfaces. It is also important to develop specific technologies for the creation and control of such phase interfaces. Phase interfaces exist in each of the multi-scale structures. Hence, in order to apply our better understanding of nanoscale phenomena or the outcome of materials research in real systems, we need additional bases for holistic analysis and design, as in measurement techniques and the mathematical sciences of modeling and simulation. The integration of these results will certainly lead to much reduced energy loss in various equipment and new methods of energy saving and production, and also dramatic performance improvements and cost reduction of related technologies. In addition, it should be noted that phase interface science is related to every production and consumption activity of human beings. Therefore, we hope the outcome of this research will contribute not only to resolving energy issues but also to providing common knowledge for a broad range of scientific and technological areas.

In order to accomplish the goals of the present research area, research proposals should meet the following policies.

(1) Recognizing that energy is one of the most urgent issues for Japan and the present CREST is funding issue-driven research resolving this issue, research proposals should clearly aim for efficient energy utilization through fundamental science and technology breakthroughs.

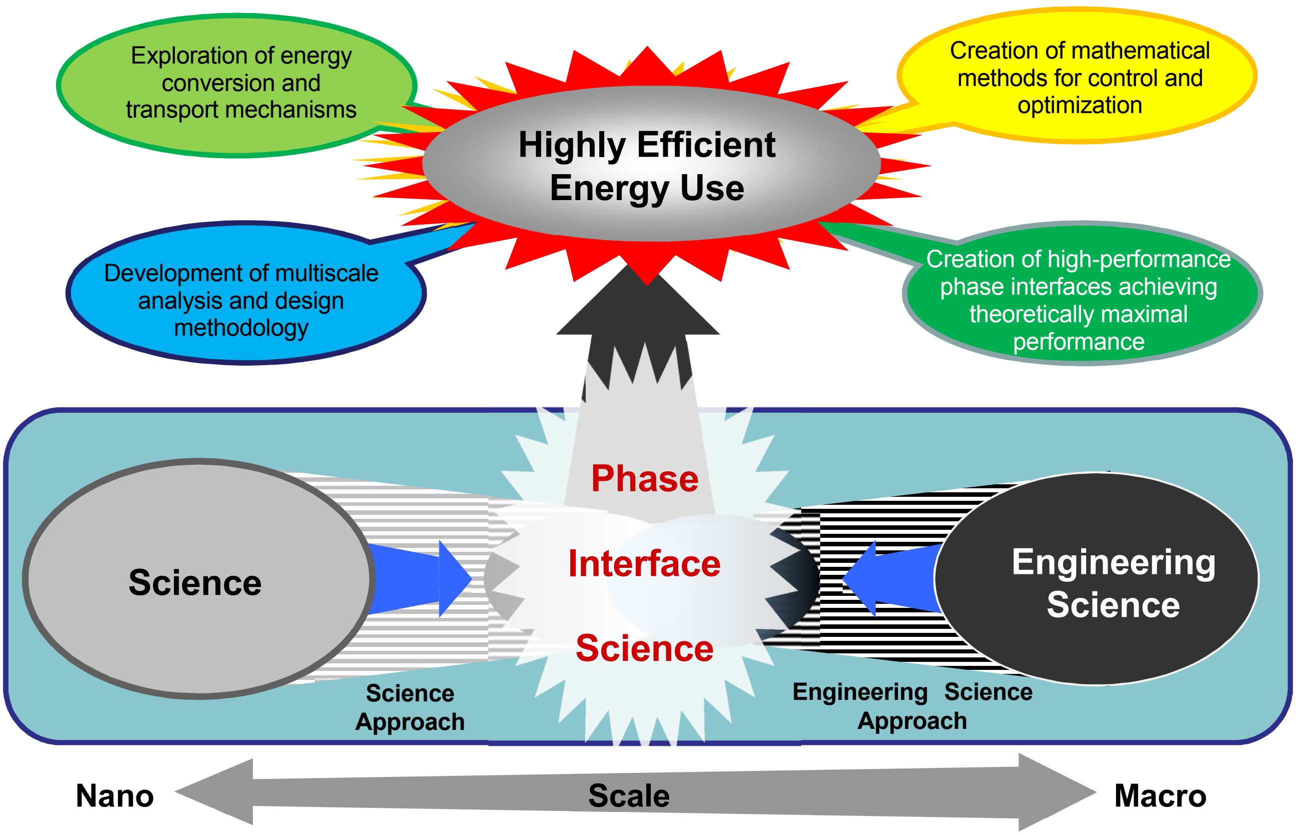
(2) Basic research proposals are desirable targeting the massive introduction of a specific technology to the market through marked increases in either energy utilization efficiency or drastic cost reductions. In other words, research proposals are evaluated from the viewpoints of both technical renovation and quantitative contribution to efficient energy use.

(3) Possible research challenges are, for example, to elucidate the fundamental processes of interfacial phenomena; to develop advanced measurement, modeling, and simulation methods; and to design the most appropriate phase interface. However, research proposals with a clear route for achieving efficient energy use are desired rather than those just aiming for exploring mechanisms or developing general analytical and measuring methods.

(4) Coordination and fusion of multiple disciplines should be vital to achieving the goals of this research area. Therefore, challenging proposals from research teams consisting of scientists of various scientific disciplines and technological fields are most desirable. At the same time, research plans to actively develop such cross-discipline collaboration are also encouraged.

We welcome a research team composed of researchers from a broad range of scientific fields, including materials, chemistry, mechanics, electronics, systems, physics, and mathematics. We believe that there would be two incipient approaches toward the coordination and fusion: Science Approach, which aims at drastic efficiency increases primarily based upon the microscopic details of phase interface phenomena and materials performance, and Engineering Science Approach, which aims at the same but based on actual systems, equipment structures, and/or devices. We therefore ask applicants to specify which approach they will be mainly taking (see note). Teams that are taking both approaches are welcome, but we ask that one or the other be specified. In either case, we encourage all participating research teams will gather and make a great challenge of achieving new breakthroughs for a paradigm shift in energy utilization.

In order to promote the interdisciplinary research activities mentioned above and cultivate synergistic effects through collaboration and cooperation between CREST and PRESTO researchers, we plan to implement a dynamic operation strategy including joint meetings and symposia.



Note: When applying, please write, at the beginning of *Title of the research* of *Proposal for Research* (Form 1), "S approach" or "E approach" depending on selecting the science approach or the engineering science approach. Please also designate "S approach" or "E approach" at the beginning of *Title of the research and development* on e-Rad.

4.1.9 "Phase Interfaces for Highly Efficient Energy Utilization" <PRESTO>

Research Supervisor: Nobuhide Kasagi
(Professor Emeritus, The University of Tokyo / Principal Fellow, CRDS, JST)

Outline of Research Area

The primary goal of this research area is to greatly advance fundamental science and technology, which include exploration of phase-interfacial energy conversion/transport phenomena and creation of high-performance phase interfaces, in order to achieve ever more efficient energy utilization and thus to realize an enriched sustainable society.

Specifically, we take up the challenge of creating phase interfaces with significantly reduced energy losses and/or those for highly efficient energy use by deepening fundamental theory and control/optimization methodology of phase interface phenomena. To accomplish these goals, it is indispensable to establish analytical and design techniques integrating nano-, meso- and macro-scales, as well as theoretical methods for the control and optimization of phase interface structures. Furthermore, it is important that the results of such cutting edge fundamental research should be transferred and effectively applied to the design of real equipment and systems, leading to dramatically improved performance, reduced carbon emissions and lower costs.

The ultimate goal of this research area, therefore, is to elucidate energy conversion and transport mechanisms at phase interfaces in order to enable highly efficient energy use; to develop measurement, modeling and simulation methods for integrative analysis and design of phase interface phenomena at multiple scales; to establish mathematical methods for the control and optimization of phase interface structures; and to realize highly functional phase interfaces that allow for theoretically possible maximal performance in actual devices and equipment. To meet these goals, we encourage integrated challenges that go beyond the bounds of existing scientific disciplines and combine the knowledge gained in different fields.

Research Supervisor's Policy on Call for Application, Selection, and Management of the Research Area

To overcome global problems, such as climate change and resource depletion, and to build an enriched sustainable society, we should, based on the assessment of target technologies in terms of how much contribution they potentially offer, raise their energy utilization efficiency to their limits and seek completely new alternative energy technologies. Improving both energy utilization and harvesting efficiencies has become ever more important research and development goals.

Devices and equipment related to energy always contain boundaries with components of a variety of materials in the solid, liquid, and gaseous states (phase interfaces), and many rely upon the exploitation of mechanical, chemical, or electromagnetic phenomena that occur at such boundaries. The current performance of such energy-related systems, however, is far inferior to their theoretical performance limits. This is due to irreversible losses in energy conversion, transport, and storage processes, and in many cases, these losses are associated with phase interface phenomena. Therefore, achieving a substantial reduction in such irreversible losses is a fundamentally important R&D goal for energy saving, better efficiency, and utilization of new energy resources.

Examples of outstanding challenges include improvement of thermal energy conversion efficiency through control of complex turbulence and boiling; reduction of friction loss in transport vehicles; investigation of the electrochemical reaction mechanisms on the electrode surfaces in fuel cells and secondary batteries as well as the optimization of materials and morphology at their phase interfaces; analysis and optimization of the fundamental processes of electric power generation and fuel production from solar energy; renovation of heat pumps through advanced technologies for heat/mass transfer and phase separation; detailed analysis of separation membrane structures and optimizing a pore diameter and phase interface structures; and efficiency improvement of power semiconductor devise through phase interface control.

An effective step toward solving these problems should be to further our understanding of basic principles related to phase interface phenomena and to use the newly gained knowledge in the design and demonstration of ideal surfaces. It is also important to develop specific technologies for the creation and control of such phase interfaces. Phase interfaces exist in each of the multi-scale structures. Hence, in order to apply our better understanding of nanoscale phenomena or the outcome of materials research in real systems, we need additional bases for holistic analysis and design, as in measurement techniques and the mathematical sciences of modeling and simulation. The integration of these results will certainly lead to much reduced energy loss in various equipment and new methods of energy saving and production, and also dramatic performance improvements and cost reduction of related technologies. In addition, it should be noted that phase interface science is related to every production and consumption activity of human beings. Therefore, we hope the outcome of this research will contribute not only to resolving energy issues but also to providing common knowledge for a broad range of scientific and technological areas.

In order to accomplish the goals of the present research area, research proposals should meet the following policies.

(1) Recognizing that energy is one of the most urgent issues for Japan and the present CREST is funding issue-driven research resolving this issue, research proposals should clearly aim for efficient energy utilization through fundamental science and technology breakthroughs.

(2) Basic research proposals are desirable targeting the massive introduction of a specific technology to the market through marked increases in either energy utilization efficiency or drastic cost reductions. In other words, research proposals are evaluated from the viewpoints of both technical renovation and quantitative contribution to efficient energy use.

(3) Possible research challenges are, for example, to elucidate the fundamental processes of interfacial phenomena; to develop advanced measurement, modeling and simulation methods; and to design the most appropriate phase interface. However, research proposals with a clear route for achieving efficient energy use are desired rather than those just aiming for exploring mechanisms or developing general analytical and measuring methods.

(4) Challenging research plans for the issues of multiple disciplines are desirable, but those targeting a single technology and trying to achieve its drastic performance improvement would also be acceptable.

(5) PRESTO is intended for encouraging individually planned research by young researchers.

We welcome researchers from a broad range of scientific fields, including materials, chemistry, mechanics, electronics, systems, physics, and mathematics. We encourage applications of researchers of such disciplines working together with unique ideas based on science toward the single goal of achieving new breakthroughs for a paradigm shift in energy utilization.

In order to promote interdisciplinary research, we intend to foster frequent information exchanges and discussions between participating researchers. We also strongly encourage collaborations between researchers from different fields. We plan to implement a dynamic operational strategy, including joint meetings and symposia in conjunction with CREST research teams.

Research Area in the Strategic Object:
"Creation of basic technologies for utilizing plant photosynthetic functions and biomass that will enable the actualization of efficient carbon dioxide utilization"

4.1.10 "Creation of essential technologies to utilize carbon dioxide as a resource through the enhancement of plant productivity and the exploitation of plant products" <CREST&PRESTO>

Research Supervisor: Akira Isogai (Professor Emeritus, Nara Institute of Science and Technology)

Outline of Research Area

This research area targets the creation of essential technologies for utilizing carbon dioxide as a resource through the enhancement of plant photosynthesis and the exploitation of plant products. In detail, the research topics include 1) developing essential technologies that enhance photosynthetic potential through an integrative and systematic approach to understanding the regulatory mechanisms of photosynthesis, the basis of material productivity in plants, with consideration of the interaction between metabolism and translocation of photosynthetic products and other metabolic pathways, such as nitrogen assimilation; 2) developing essential technologies that improve the photosynthetic activity, carbon storage potential, and biomass productivity of plants through the elucidation of the mechanisms by which plants adapt to various environments; and 3) the study of mechanisms of biomass production and decomposition and the development of technologies for improved biomass utilization. In parallel with these three research topics, this research area focuses on collaboration and synergy in the fields of plant science and biomass engineering.

Research Supervisor's Policy on Call for Application, Selection and Management of the Research Area

All the carbon compounds present on Earth have been formed by plant photosynthesis, where carbon dioxide is reduced to organic compounds using solar energy. Fossil fuels are also derived from photosynthetic products. The growing social need for a sustainable energy supply and conservation of the global environment by curbing carbon dioxide emissions indicates that plant photosynthetic activity and the biomass generated are being reassessed as basic technologies for utilizing carbon dioxide as a useful resource.

Japanese plant biologists have made great progress in research, particularly research on model plants. Genes and molecules involved in photosynthesis and various physiological functions evolved by plants during their adaptation to various environments have been identified. Based on this research, improvements in independent elements have been made in photosynthesis efficiency using new plant variants and technologies have been developed for exploiting the biomass produced. The time has now come for Japanese plant scientists to help solve the social problems mentioned above. To meet the needs of society and to develop practical technologies, it is necessary to establish a research structure that allows plant scientists to utilize their skills in an integrated manner by targeting crops and other practically useful plants. Therefore, close cooperation and a clear sense of purpose is needed among researchers.

This research area is supported by CREST and PRESTO, which were established to promote research to address current challenges. As mentioned in the Outline of the Research Area, the aims of this research are twofold: (1) the effective utilization of carbon dioxide by understanding and altering the material productivity of plants, e.g., enhancing the photosynthetic potential and exploiting environmental adaptations of plants; and (2) the development of essential technologies for converting photosynthetic products, such as biomass, into valuable products. For each CREST research project, a team should be assembled that integrates a wide variety of research fields. For example, a project may focus on improving the efficiency of several reaction steps in photosynthesis and creating plants that utilize these improvements. Alternatively, a project may focus on elucidating metabolic and catabolic pathways, although it should be connected to the development of technologies for producing valuable materials using altered metabolic profiles. Another project may focus on fundamental technology that bridges plant biomass decomposition and the synthesis of functional materials by chemical engineering and bacterial cell functions. A PRESTO project must involve bold and challenging research with a unique perspective or original and novel research that would be difficult to conduct in a more conventional team-based structure. This research will target the production of fundamental technologies for next and later generations. These two types of research will be promoted in a synergistic and integrative manner by the Research Supervisor in this research area. Interaction and collaboration within these research projects will accelerate the progress of each project and contribute to innovation in a broader field. We hope to achieve further progress by promoting connections across disciplines such as science, agriculture, engineering, pharmacology, and so on. Until now, research has been conducted separately in these fields. Tremendous progress can be expected if there are improved collaborations across various fields and with other R&D programs, particularly those related to plant functions for material production.

In our first and second years, we have incorporated 4 CREST teams and 11 PRESTO researchers, and 5 CREST teams and 10 PRESTO researchers, respectively. We look forward to receiving ambitious research proposals in response to our last call for proposals, which should address societal issues related to global environment conservation and the development of a sustainable society from the perspectives of photosynthesis, environmental adaptation, and biomass utilization.

Research Area in the Strategic Object:
"Creation of basic technologies for understanding marine ecology highly efficiently and forecasting marine life changes to conserve and regenerate the marine biodiversity required for sustainable usage of ocean resources"

4.1.11 "Establishment of core technology for the preservation and regeneration of marine biodiversity and ecosystems" <CREST>
Research Supervisor: Isao Koike (Inspector General, University of the Ryukyus)

Outline of Research Area

In this research area, we will pursue cutting-edge research and development of observation and monitoring techniques and prediction models in order to advance the understanding of marine biodiversity and ecosystems. Toward this end, our goal is to establish the core technology essential to the conservation and restoration of marine biodiversity and ecosystems.

In recognition of the current bottleneck in research on marine biodiversity and ecosystems, emphasis is placed on techniques for acquiring biological data, including environmental factors, as well as on prediction modeling. This research area is focused on (1) developing broad, continuous sensing and monitoring techniques for marine organisms and biological populations as well as related environmental factors, in order to improve the efficiency of species identification and biomass estimation and to develop cutting-edge techniques for accumulation and integration of basic biological and environmental data through analysis of ecological networks; and (2) developing novel models for understanding spatial and temporal changes in marine ecosystems and biodiversity and for making predictions about these biological systems.

To investigate items (1) and (2), researchers participating in each project must identify marine biological populations and/or biological processes which are the target of the proposed technique or model. In other words, field research and monitoring are required for validating the developed techniques and models; furthermore, close collaboration is necessary across a wide range of research disciplines. This research area, however, does not appreciate only observational investigations or monitoring of marine species and biological populations.

To overcome the traditional limitations on marine research, we strongly recommend collaborative research between researchers engaged in marine biological sciences (such as marine ecology and taxonomy) and researchers from a wide array of disciplines in engineering and life sciences. Through collaborative research with clearly defined targets, this research area can make significant contributions to policymaking for the conservation of marine environments, including the establishment of marine protected areas and sustainable use of marine resource that takes into account of negative effect on marine organism.

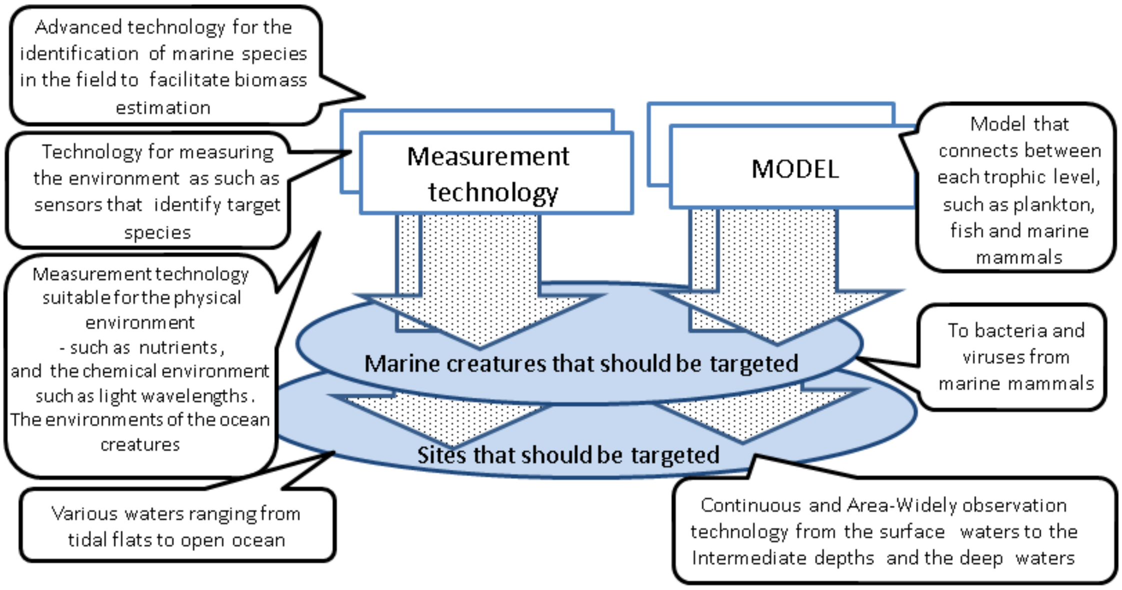
Research Supervisor's Policy on Call for Application, Selection, and Management of the Research Area

There are concerns that changes to the environment over the recent years, such as the global climate change triggered by human activities and the Great East Japan Earthquake in March 2011, may affect marine biology. To promote the sustainable development of human society, it is necessary to obtain benefits from the ocean, such as the use of marine biological and mineral resources, while ensuring that marine ecosystems are not disturbed and that biodiversity is maintained. However, at present, our scientific knowledge of marine ecosystems and biodiversity is limited, and the existing core technologies and datasets available for improving this knowledge are insufficient.

Therefore, this Research Area aims to conduct research in the development of survey technologies as well as biodiversity and ecological models, with clearly defined goals. In particular, we hope to contribute to resolving the serious environmental issues faced by Japan such as "making the social infrastructure more eco-friendly" and "tackling global problems."

Future outputs in this research area are as follows: implementing measures to conserve marine biodiversity and the environment in various types of ecosystems; the sustainable use of marine biological resources; and improving the understanding of how large-scale natural disasters such as major undersea earthquakes and tsunamis affect marine ecosystems, as well as devising measures that facilitate rapid recovery from such disasters. However, the focus of this research area is to develop fundamental technologies and models that support the above outputs.

This Research Area also targets all levels of biodiversity in the ocean including genetics, species, and ecosystems. The goals are the development of advanced technology, original ideas, and identifying advanced technology from other areas that can be applied to and deployed in the ocean. All oceanic areas will be targeted in this study, e.g., coastal areas, open water, deep seas, and coral reefs. The concept of biodiversity encompasses diversity at the genetic level, the species level, and the ecosystem level. Thus, we will focus on marine biodiversity at these three levels. This research area also includes studies of the functions of ecosystems based on bioelement cycling, which is one of the major marine ecosystem services. We will identify examples of technical development in the following areas. We will also welcome highly challenging research proposals based on entirely new ideas in addition to these examples.



Last year, we received 38 applications and 13 proceeded to the interview selection stage. Six were accepted as final proposals.

We focused on the following perspectives during selection.

- The proposal should specifically identify bottlenecks in marine biodiversity and ecosystem studies and suggest solid ideas for new technological developments that could address these bottlenecks.
- The proposal should not focus on studies involving surveys and research using available technologies and methods.
- How innovative are the proposed models?

Many proposals did not provide sufficient explanations for these points; therefore, unfortunately, we had to reject those proposals. In addition to the perspectives presented last year, we will use a more specific selection policy that focuses on the following points.

-We will prioritize compact research proposals with a narrower focus of studies. (We do not value proposals for expensive research with ambiguous purposes. Larger outputs are expected for proposals of expensive research.)
- We do not accept research that is based mainly on observations. (Observations should be used for demonstration and verification purposes only.)
- We welcome proposals where researchers and companies from different fields, such as engineering and the life sciences, play central roles in technical development.
- If the main proposal is the technical development, it is preferable that the proposal will demonstrate its preliminary efficacy in the field of oceans as well as an observation group for demonstration and validation until after the mid-term evaluation.
(We will introduce the participants to facilitate cooperation in this research area and to aid the observation group.)
- We welcome joint research involving researchers from Japan and overseas to study diversity and ecosystem models.
(We will not accept simple applications of available models.)
- We welcome proposals from young researchers in their 30s and 40s.

This research area includes key words such as marine biodiversity, ecosystem, new survey technologies, and models. We are expecting to see dramatic progress in the field of ocean research by encouraging the participation of researchers who have not been involved in the field of marine studies, such as environmental groups and fisheries organizations. The major objective of this research area is to develop technologies as study outcomes that will contribute to addressing specific problems in marine research by establishing clear goals.

We welcome proposals that involve aggressive cooperation with the research themes, which was adopted in the past when you proposed this theme. After the proposals are accepted, researchers are expected to associate actively with other projects and to implement studies that facilitate integrated efforts in the overall research area.

4.2 Life Innovation

Research Area in the Strategic Object:

Creation of core technologies for early-stage drug discovery through the investigation of disease-specific profiles of biomolecules

4.2.1 "Creation of Innovative Technology for Medical Applications Based on the Global Analyses and Regulation of Disease-Related Metabolites"<CREST>

Research Supervisor: Takao Shimizu

(Director-General, Research Institute, National Center for Global Health and Medicine)

Outline of Research Area

The aim of this Research Area is to create breakthrough technology platforms based on biomolecular dynamics analysis, the outcomes of which will contribute to medical applications such as drug discovery, disease diagnosis, and prevention. The technology platforms should increase the capacity of current systems to find, identify, and quantify disease-related metabolites and their associated factors as potential target molecules for disease control and broader medical applications.

In particular, metabolomics and other "omics" approaches are in great demand for the identification of disease-associated factors; therefore, these need to be developed. Further, we need the technology to identify proteins and other biomolecules related to these factors so they are within the scope. By combining biomedical research projects with the newly developing technology platforms, this Research Area aims to deliver proofs of concept for human disease control by taking full advantage of information obtained about core biomolecules as potential targets for medical applications.

The technical goals specified by the Research Area should be shared among individual research projects. Therefore, the management strongly encourages them to collaborate with others within this so-called virtual-network-type institute as well as with projects in the corresponding Precursory Research for Embryonic Science and Technology (PRESTO) Research Area, both aiming for the establishment and sophistication of technologies in a team-oriented manner. The management also prioritizes smooth translations to clinical applications; therefore, it considers further efforts allied with other drug discovery programs.

Research Supervisor's Policy on Call for Application, Selection, and Management of the Research Area

This Research Area aims to increase the national capacity for research and development by establishing a technology platform for activities related to drug discovery and disease diagnosis. After its completion, the technologies developed should provide accessible resources to those in this field of research, and tangible outcomes should be demonstrated to the industry or other sectors, where their efforts will reach out to the public. Bearing this in mind, we accept proposals with high quality and originality, particularly prioritizing those with potential for contribution to the aforementioned national resources. Proposals should clarify their technical goals such as metabolites analysis, target identification, disease control, or anything else stated in the Strategic Object.

Applicants to our first call for proposals should read the following subsections carefully, which explain what we expect from the program portfolio in terms of technology, metabolic pathways and related diseases, and our management policy. Please also note that **we plan to accept proposals only twice: it is advised that potential applicants consider this FY2013 call or another one planned in FY2014 (next year) to avoid missing the opportunity (no call currently planned in FY2015)**.

1. The technology portfolio

This Research Area develops technologies for drug discovery (including those leading to disease control) by exploiting the knowledge obtained by the analysis of disease-specific profiles of biomolecules. Any contributors to this technological challenge are broadly welcomed.

There are two ways of approaching the challenge. One is a "reverse" approach, where global analyses of metabolites and other molecules are conducted to discover potential biomarkers (e.g., for early diagnosis or predictive prognosis) or drug targets. The other is a "forward" approach, where known physiologically active compounds are introduced to analyze their associated metabolites, binding proteins, and related metabolic pathways, thereby developing novel diagnostics or identifying drug targets. Both of these approaches are within the scope.

In the "reverse" approach, we will primarily consider the following technological elements: sampling and preparation of bodily fluids or tissues; separation, purification, synthesis of standards, quantification or profiling of metabolites; and correlative studies of these metabolites in the specific context of target diseases. We anticipate that diagnostics development will be included in this approach.

In the "forward" approach, any technology that facilitates the following will be considered: identification of factors that bind to known physiologically active compounds (e.g., biomolecules, natural and synthetic compounds, or existing drugs including failed candidates); identification of molecules associated with these binding factors; and identification of potential biomarkers or drug targets inferred from this information.

Applicants should note that, while the two aforementioned approaches exemplify core technologies, any other technologies that may contribute to the identification of drug targets or the development of novel diagnostics will also be considered.

2. The pathway portfolio and related diseases

This Research Area aims to orchestrate all research projects to establish a flagship technology platform for activities related to drug discovery and disease diagnosis. To maximize the benefits under budget restrictions, we plan to allocate the resources based on a consideration of strategic target diseases and technologies.

Priority will be given to major metabolic pathways in humans where associations with diseases are under study. Sugars, lipids, amino acids and peptides, nucleic acids, secondary metabolites, and related molecules are key players so there is a need to investigate correlations between their metabolic pathways and related diseases using mass spectrometers and other instruments. Applicants should note that the technology portfolio (described in the subsection 1) will be linked to this priority.

The target diseases being considered are cancer, diabetes, immune and inflammatory diseases, infectious diseases, and psychiatric and neurological diseases. Existing reports indicate that specific enzymes and metabolites are correlated with these target diseases.

Cancer can be categorized into various types. Our focus will be on types where the patients have unmet needs (e.g., lung, pancreatic, and liver cancers) and types with a high incidence in Japanese populations (e.g., colon and gastric cancers). We aim to establish original, novel technologies for diagnosis and disease control.

Diabetic complications are other targets. They contribute to a significantly poor prognosis or quality of life for patients where no curative treatment options are available. We attempt to advance technology development for early diagnosis and the control of complications from a biomolecular perspective.

Of the immune and inflammatory diseases, we will focus mainly on those designated as "intractable" by Japan's Ministry of Health, Labour and Welfare. An improved treatment outcome has been achieved for immune diseases using biopharmaceuticals, but they come with a high cost and their sometimes limited effectiveness may hamper the potentially larger benefits for patient populations. Thus, innovative new drugs (including small molecules) are still awaited in this disease category. Infectious diseases are also within the scope in order to advance their early diagnosis or their pathological understanding through secondary metabolites analysis and associated studies.

Psychiatric and neurological diseases are a major challenge for the Japanese population. Our aged society will inevitably comprise an increasing number of patients who suffer from dementia and other neurological diseases. Other age groups are included when we consider depression. We aim to establish a technology platform that will be applicable to the development of early diagnosis and new treatment approaches.

3. Our management policy and its influence on the call for proposals

We stress that this Research Area aims to orchestrate all research projects to establish a flagship technology platform for activities related to drug discovery and disease diagnosis (see subsection 2). This requires a strong motivation for intense collaboration among research projects related to technology development and disease control, which aims to establish synergies and emergent effects rather than simple sharing of research results.

This first call for proposals will be an opportunity for us to welcome as many technology development challenges as possible because we believe that the anticipated technology platform will play a key role in the aforementioned synergistic effects to achieve our goals. Research projects that contribute to the platform should also act as a support hub for the entire Research Area, which is a virtual network-type institute, by collaborating with other projects on disease control and providing them with technical support in metabolites analyses or target identification. To ensure this synergy, a project extension may be considered if we evaluate them as necessary and extraordinarily productive.

The subsequent call(s) for proposals will mainly be for proof-of-concept challenges in disease control. Applicants with their own libraries of physiologically active compounds who intend to adopt the “forward” approach (see subsection 1) should propose plans where they will conduct global correlation analyses of their targets, which would be well-validated and transferrable to industry. Those proposing medical applications based on biomolecular analyses who intend to adopt the “reverse” approach (also see subsection 1) should aim to discover novel targets based on the best use of available resources in this Research Area.

This Research Area permits budget requests of up to 300 million JPY per research project. An exceptional consideration will be given to those that aim to function as our technology support hub where the budgetary ceiling may be increased to around 400 million JPY.

4. Other information

For applicants considering joining to form our technology support hub:

We welcome applications from teams with high degrees of competence. We have high regard for past achievements and experiences during appraisal. For example, an ideal research team for a metabolites analysis function should comprise group(s) or organization(s) that have already been offering support through joint research agreements or contracts, or at least those who are willing and able to present a concrete plan to offer such support.

For applicants considering proposals on disease control:

We anticipate project proposals that will produce innovative technology. The following are examples of our wish list: high-throughput identification of enzymes or other proteins and molecules associated with disease-related metabolites; and the precise and accurate identification of target molecules based on multi-omics analyses.

4.2.2 “**Creation of Innovative Technology for Medical Applications Based on the Global Analyses and Regulation of Disease-Related Metabolites” <PRESTO>**
Research Supervisor: Yoshiya Oda (President, Biomarkers and Personalized Medicine Core Function Unit, Eisai Product Creation Systems)

Outline of Research Area

The aim of this Research Area is to create breakthrough technology platforms based on biomolecular dynamics analysis, the outcomes of which will contribute to medical applications such as drug discovery, disease diagnosis, and prevention. The technology platforms should increase the capacity of current systems to find, identify, and quantify disease-related metabolites and their associated factors as potential target molecules for medical applications.

In particular, this Research Area will focus on the development of ultrasensitive detection methods to discover novel disease-associated factors, accurate identification and quantification of newly detected factors, drastically higher throughput analysis, multiplex analysis, and related information technologies. Simultaneously, efforts will be made to establish and advance a series of technology for target analysis based on the repositioning of known physiologically active compounds to understand target metabolites, proteins, and metabolic pathways, as well as for elucidating the mode-of-action of potent compounds where the molecular mechanisms are still unknown. By diversifying current technological approaches, these challenges promise to contribute a proof of concept of human disease control by taking full advantage of the information obtained about core biomolecules as potential targets for medical applications.

This Research Area encourages interdisciplinary approaches ranging from nanotechnology, synthetic chemistry, engineering, and other related fields, to the life sciences, expecting them to culminate in seminal, often transformative research that leads to innovation. Moreover, the resources for research management will be shared virtually with the corresponding Core Research for Evolutionary Science and Technology (CREST) Research Area to facilitate intense collaboration. Thus, individual PRESTO researchers should take responsibility for their own projects and for the team, as members of the virtual-network-type institute, to ensure that mutual benefits are accrued by the two Research Areas.

Research Supervisor’s Policy on Call for Application, Selection, and Management of the Research Area

This Research Area aims to develop technology platforms that facilitate the analyses of target molecules for drug discovery and diagnosis, which will rely primarily on the detection, identification, and quantification of factors related to diseases. Among these factors, the focus will be on disease-related metabolites. We aim to promote research and development into the analysis of these metabolites and their associated proteins, miRNAs, and other molecules. As a nationally driven, top-down program we emphasize the sharing, implementation, and eventual application of the research outcomes, although we also value original individual research projects. Applicants should meet the criteria for PRESTO researchers and their proposals should be highly original and transformative, while envisioning clear real-world applications. Those selected will be asked to collaborate, merge, or apply their outcomes to research projects in the corresponding CREST Research Area to ensure maximum impact.

Applicants to our first call for proposals should read the following subsections carefully, which explain what we expect from the program portfolio in terms of technology, metabolic pathways and related diseases, and our management policy. Please also note that **we plan to accept proposals only twice: it is advised that potential applicants consider this FY2013 call or another one planned in FY2015 (two years later) to avoid missing the opportunity (no call currently planned in FY2014)**.

1. The technology portfolio

This Research Area will develop technologies for the biomolecular analysis of targets to facilitate drug discovery, disease diagnosis, and prevention via omics profiling.

Among the “-omics” approaches (including genomics, transcriptomics, proteomics, and metabolomics), recent trends have indicated relationships between specific diseases and the metabolomics profile, which is a closer look at phenotypic representations of the information encoded in the genome. This promising approach has led to the identification of an increasing number of pharmaceutically valuable factors in cancer research where researchers have paid full attention to the unique patterns of glycolysis and other major metabolic pathways associated with tumor growth.

We will accelerate these research trends by calling for proposals where applicants plan to accurately quantify metabolites and the associated proteins, miRNAs, and other molecules, or to identify and sensitively detect target molecules for medical applications in metabolic pathways using physiologically active compounds. They should state clearly in their proposals how their technological endeavor will result in real-world applications. Prototype development (for devices or software), testing with human samples (for fundamental biomedical technology), or any other innovations will be anticipated in addition to contributions to the corresponding CREST research projects.

The following are detailed descriptions of the technology portfolio in this Research Area.

A) Novel profiling technologies for omics studies of diseases

In this category, metabolomic, proteomic, and miRNA analyses are essential. In particular, we expect the following technological elements: ultrasensitive detection to facilitate the discovery of novel disease-associated factors, accurate identification and quantification of these newly detected factors, drastically higher throughput analysis, and multiplex analysis. We also expect the development of information technologies such as multi-omics analysis software to facilitate the profiling of disease-associated factors.

B) Analytical technologies for studying target molecules using physiologically active compounds

In this category, technologies will be developed to identify disease-related target molecules using known physiologically active compounds (e.g., biomolecules, natural and synthetic compounds, or existing drugs including failed candidates). In particular, we expect the following technological elements: identification of factors that bind to the compounds of interest (facilitated by the advanced development of affinity capture materials, the improvement of precision and accuracy of analysis, or other ways); identification of molecules associated with these binding factors (facilitated by the use of proteomic, genomic, and related omics analyses); target evaluation and validation; and application in drug discovery or diagnosis using the newly-identified disease-related biomolecules.

In addition, measurement using minimal sample volumes, data reproducibility, portability, versatility, usability, and other practical advantages will be significant bonuses in categories A and B. Quality proposals with achievable plans for real-world applications are highly welcomed.

2. The pathway portfolio and related diseases

As stated previously, this Research Area aims to develop innovative technologies that range from omics analyses and target identification to disease diagnosis and prevention. The research outcomes should make progress toward human disease control with applications in their corresponding CREST research projects. Therefore, given the potential synergies with their target diseases, we will give preference to research plans that are highly compatible with disease models or clinical samples available in the CREST research projects, particularly technology development that is directly applicable to drug discovery, disease diagnosis, and prevention. Applicants are advised to refer to the following descriptions of strategic targets with respect to metabolic pathways and related diseases, which are cited from the CREST Research Area.

Priority will be given to major metabolic pathways in humans where associations with diseases are under study. Sugars, lipids, amino acids and peptides, nucleic acids, secondary metabolites, and related molecules are key players so there is a need to investigate correlations between their metabolic pathways and related diseases using mass spectrometers and other instruments. Applicants should note that the technology portfolio (described in the subsection 1) will be linked to this priority.

The target diseases being considered are cancer, diabetes, immune and inflammatory diseases, infectious diseases, and psychiatric and neurological diseases. Existing reports indicate that specific enzymes and metabolites are correlated with these target diseases.

Cancer can be categorized into various types. Our focus will be on types where the patients have unmet needs (e.g., lung, pancreatic, and liver cancers) and types with a high incidence in Japanese populations (e.g., colon and gastric cancers). We aim to establish original, novel technologies for diagnosis and disease control.

Diabetic complications are other targets. They contribute to a significantly poor prognosis or quality of life for patients where no curative treatment options are available. We attempt to advance technology development for early diagnosis and the control of complications from a biomolecular perspective.

Of the immune and inflammatory diseases, we will focus mainly on those designated as “intractable” by Japan’s Ministry of Health, Labour and Welfare. An improved treatment outcome has been achieved for immune diseases using biopharmaceuticals, but they come with a high cost and their sometimes limited effectiveness may hamper the potentially larger benefits for patient populations. Thus, innovative new drugs (including small molecules) are still awaited in this disease category. Infectious diseases are also within the scope in order to advance their early diagnosis or their pathological understanding through secondary metabolites analysis and associated studies.

Psychiatric and neurological diseases are a major challenge for the Japanese population. Our aged society will inevitably comprise an increasing number of patients who suffer from dementia and other neurological diseases. Other age groups are included when we consider depression. We aim to establish a technology platform that will be applicable to the development of early diagnosis and new treatment approaches.

3. Our management policy

Collaboration among diverse fields of research will be encouraged greatly in this Research Area. We plan to present as many opportunities as possible for individual PRESTO researchers to communicate, discuss, and share their knowledge and ideas with others. In addition, we will support them to develop new ideas and collaborative research projects by optimizing their relationships with the corresponding CREST Research Area under the same Strategic Object. Further efforts allied with other programs at a higher level will also be given consideration.

Research Area in the Strategic Object:

Integrated clarification of the maintenance and change mechanisms of dynamic homeostasis in the body and creation of technology to understand and regulate complex dynamic homeostasis to achieve preventive medicine, appropriate diagnosis and treatment

4.2.3 "Innovation for Ideal Medical Treatment Based on the Understanding of Maintenance, Change and Breakdown Mechanisms of Homeostasis among Interacting Organ Systems" <CREST>
Research Supervisor: Ryozo Nagai (President, Jichi Medical University)

Outline of Research Area

The objective of this research area is to comprehend the process from birth to demise, which takes place in the individual, from the view of a dynamic homeostatic mechanism and to elucidate the mechanisms as to how the individual adapts and changes in reaction to internal and external stresses in a spatio-temporal and cross-sectional manner. The dynamic homeostatic mechanism is operated via a high-order network consisting of the nervous, immune, endocrine, circulatory, and other systems. Furthermore, we aim to understand various diseases, including lifestyle diseases, as deviations from or breakdown of a "homeodynamic" state, constituting a ground for the development of preventive technologies that predict and control such deviation.

Particularly in recent years, technologies such as development of cell-specific genetically modified animals and cell separation technologies have made great progress and they have triggered major changes in life science and medicine. Expectations are to gain a better understanding of mechanisms of homeostasis and adaptations to various stressors, which function through interactions between different cells, systems, and organs. Furthermore, advances in life science and clinical medicine that control these mechanisms are needed. Specifically:

1. How complex functional networks behave interdependently in order to maintain homeostasis in response to external and internal stresses will be elucidated. These networks correlate among multiple organs, such as between parenchyma cells and interstitial cells, among organs as well as among the systems like the nervous, immune, endocrine, circulatory and others. In particular, humoral factors, neurotransmission, immunocytes, and interstitial cells that are involved in the maintenance and dysfunction of homeostasis need to be identified. These findings are needed to develop technologies that can be used to control homeostasis.
2. Researchers are expected to elucidate the phases of sequential and dynamic changes that take place in an individual's homeostatic mechanism during the life stages through birth, growth, development, and aging. Technologies that enable early detection of the subtle symptoms of these phases, as well as those to control them, are to be developed.
3. This research area involves research aiming at elucidation of the mechanisms in onset and progression of organ dysfunction resulting from internal and external factors, the biological defense mechanisms against stresses and injuries and healing mechanisms. Furthermore, we aim to develop technologies that will assist in the diagnosis and treatment of human patients. We will apply results of basic research for examination in clinical cases as much as possible, and investigate the potential of medical care where multiple medical departments cooperate based on new concepts of pathology.
4. We aim at the establishment of highly reliable methods to control these networks, based on multilateral understanding of the dynamic interactions between these complex networks. To achieve this goal, we will work to promote simulation technologies and theoretical computational science research that would make these technologies possible.

Through this research, we will elucidate previously unknown molecular, cellular, and networking mechanisms and develop new medical technologies based on these understandings.

<u>Research Supervisor's Policy on Call for Application, Selection, and Management of the Research Area</u>

Our research views homeostasis and the onset of disease as interactions between complex biological systems. The objective of this research is to develop fundamental technologies that will contribute to the realization of ideal medical care. For that purpose, it is necessary for us to conduct our research from the following standpoint.

Biological homeostasis includes not only a feedback system that is activated by stress in the short term, but also the system which allows changes to the index point which occur over a longer period. Regulation of the system is achieved via inter-organ cooperation, as well as cooperation between the autonomic nervous, endocrine, immune, cardiovascular and other systems. A wide variety of cells and humoral factors with currently unknown functions play a role in this complex interaction.

This type of research is important in order to understand and overcome disease. Many pathological conditions can be understood as a breakdown in the stress adaptation mechanism. The process leading to organ dysfunction is not simply a primary biological reaction, but progresses to secondary and tertiary reactions—involving structural remodeling and functional changes where inter-system and inter-organ coordination can be observed. These biological reactions have long been known, although the molecular and cellular elements of these reactions were not always clear. Notably, a new type of life science pertaining to homeostasis and pathophysiology is rapidly being developed by the progress in development of genetically modified animals and cell separation technologies.

In response to the above, we will call for research proposals covering topics such as organogenesis, organ regeneration, adaptation to stress, and breakdown (organ dysfunction) that aim to investigate inter-system cooperation, based on the new understanding of molecular and cellular functions. By embracing new methods, the researchers who form the foundation of clinical medicine are expected to develop a new field. Armed with existing knowledge and technology, researchers in other fields who participate in the medical field will be enabled to achieve hitherto unobtainable results.

This will, however, not be easy to accomplish. We therefore welcome proposals from research teams consisting of researchers in a wide variety of fields, though each researcher has had little interaction previously, who is willing to exchange ideas and techniques and is able to participate in an environment of mutual cooperation.

As we operate in this research area, we anticipate intense discussion between teams working on different research themes, as well as leveraging the synergistic effect of nurturing incipient joint research projects. We are confident that we will achieve results by focusing the entire research field on a single goal. We invite those with the sort of open minds that will lead to synergy to respond to our call for proposals.

<<Additional notes for the FY2013 call for proposals>>

Beginning in FY2012 with five research projects, this Research Area offers a second opportunity with the FY2013 call for proposals. Each proposal will be appraised based on its overall quality, although its potential for synergy with the aforementioned projects will also be considered.

This Research Area has set the ambitious challenge of innovating ideal medical treatments, which includes, but is not limited, to preventive medicine, personalized medicine, and any game-changing approaches that may reduce medical intervention drastically. This challenge requires that each research project discovers a key factor(s) in the overall system behavior (a "node" in the higher-order homeostatic network) and to demonstrate a proof-of-concept for an intervention based on the use of these factor(s), which will improve the understanding and control of human disorders. The Outline part of a research proposal should include a concise description, which is at the sole discretion of the applicant, of the goals during the proposed research period and how they will extrapolate these achievements to update current disease definitions.

We will accept proposals at all stages ranging from basic to clinical studies, but applicants should be aware that in order to ensure the overall balance of projects within the Research Area, priority will be given to the following proposals:

- those that deal with the dynamics of homeostasis or related interactions among organ systems from a psychosomatic viewpoint (e.g., higher brain functions and the autonomic nervous system)
- those that deal with dynamic changes in physiological set points that reflect varying homeostatic mechanisms during multiple life stages in the whole organism
- those that use a theoretical approach to identify basic rules underlying the dynamics of complex network systems
- those that exploit computer simulation and modeling approaches applicable to multiscale and multiphysics phenomena, high-throughput data analysis, or other mathematical methods to elucidate the general mechanisms underlying homeostatic regulation and its systemic changes at the level of whole organisms
- those that include a concrete, specific scenario related to "Innovation for Ideal Medical Treatment" (e.g., clinical applications).

No additional prerequisites are required for the proposed budget and structure of the team to meet the CREST guidelines. However, the preferred team will influence others and take initiatives to develop new international trends because this Research Area pioneers the support of full-fledged projects on systems research at the level of whole organisms. We expect that every applicant will supervise their own team with leadership and contribute to strengthening Japan's presence in the emerging integrative understanding of biosystems.

4.2.4 "Elucidation and regulation in the dynamic maintenance and transfiguration of homeostasis in living body" <PRESTO>

Research Supervisor: Masato Kasuga (President, National Center for Global health and Medicine)

<u>Outline of Research Area</u>

We call for research proposals that purport to address the living body as a mechanism of homeostasis, thus helping elucidate the mechanisms involved in the maintenance and transfiguration of homeostasis and by extension the mechanisms involved in the onset of aging and lifestyle-related diseases. Through these lines of research, we aspire not only to provide an integrated understanding of life process at work, but also to promote the development of diagnostic/therapeutic modalities that go beyond symptomatic approaches based on this integrated understanding of life processes, but also to help optimize healthcare for individual patients according to their age and life stage.

Research endeavors of particular interest include the following perspectives:

1) the inter-organ network of functions as an integrated process;
2) changes over time in the mechanisms involved in the maintenance of homeostasis; and
3) Disruption of the mechanisms involved in homeostasis as a cause of diseases

We therefore call for research themes that purport to address the living body as a unified process in a multidisciplinary manner that goes beyond the frameworks of established specialties such as neurology, immunology, endocrinology and hematology.

Research Supervisor's Policy on Call for Application, Selection, and Management of the Research Area

It has long been thought that a mechanism is in place in the living body that responds to external stimuli or stress to maintain a stable state within the body, i.e., homeostasis as a key principle in life phenomena, which entails such broad-based and complicated processes that, until quite recently, it has remained largely unraveled.

However, advances in genetic engineering of mice have led in recent years to discovery that this mechanism involves signaling cross-talk among the organs. Indeed, this homeostasis as an inter-organ network of functions, as well as the mechanisms involved in its disruption, is now beginning to lend itself to comprehensive elucidation, thanks to advances in comprehensive exploratory techniques and bioinformatics, as well as in supercomputing capabilities.

We therefore call for research efforts focused on elucidation and regulation of this inter-organ, functional network; on elucidation of transfiguration of the homeostasis mechanism through differing stages of life from development to aging; and elucidation and regulation of lifestyle-related diseases viewed as a disruption of this homeostasis mechanism, as advances in these research efforts will contribute greatly not only to development of drugs without untoward adverse effects and diagnostic/therapeutic modalities that go beyond symptomatic approaches based on an integrated understanding of life processes at work, but also to optimization of healthcare for individual patients according to their life stage, thus establishing the base technology for preemptive healthcare required for a quickly aging society.

Clearly, to grasp dynamic homeostasis involving broad-based and complicated processes calls for multidimensional perspectives and approaches. Therefore, with the "inter-organ network of functions and their integration" serving as the key theme, we call for research themes that go beyond established specialties such as neurology, immunology, endocrinology and hematology from all areas of research including clinical an experimental medicine and experimental biology. About the current year, in addition to the above area, I would like to expect the application from fields, such as computational biology, mathematical biology, and systems biology, in an effort to construct new bases and concepts regarding homeostasis as life phenomena. We also expect this will provide an opportunity for researchers to interact proactively and synergistically by going beyond their conventional frameworks with their insights being fed back as novel perspectives in research. To this end, we heartily welcome breakthrough proposals from open-minded, young researchers and investigators.

Research Area in the Strategic Object:

Creation of new technologies for breakthrough in understanding and predicting biological activities and intermolecular interactions by means of “Novel Structural Life Science” that contributes to new medical treatment and prevention of various diseases, food safety enhancement and environmental improvement

4.2.5 “Structural life science and advanced core technologies for innovative life science research” <CREST>

Research Supervisor: Keiji Tanaka (Director, Tokyo Metropolitan Institute of Medical Science)

Outline of Research Area

This Research Area aims to integrate cutting-edge life science areas with structural biology for creating “structural life science” and advanced core technologies that will lead to innovation in life science. It will address fundamental problems in life science by integrating advanced methods of structural analysis seamlessly and establishing general principles for elucidating and predicting dynamics of hierarchical structures ranging from the atomic to the cellular and/or tissue levels.

The recent large-scale research projects in structural biology in Japan have achieved major advances in determination of protein structures with biological significance. Proteins play key roles in biological events; however, they do not function alone. Therefore, the next important step is to determine the dynamics of such proteins and to study the functional mechanisms underlying the interactions among proteins and various other biological macromolecules. For example, many diseases of animals and plants are caused by protein abnormalities. Thus, structural life science, a new branch of science proposed for understanding biological phenomena of fundamental importance based on structural methods, should play an essential role in elucidating molecular mechanisms and developing new therapeutic methods and means of disease prevention. The structural life science approach is also required for promoting a healthy and long-lived society, establishing safe food production systems, and solving environmental problems. Structural life science addresses these issues by establishing general principles underlying temporal and spatial changes of biological systems at the atomic or molecular level and by predicting dynamics of biological phenomena from these principles.

Utilizing the structural life science approaches, this CREST Research Area seeks to analyze dynamics of important functional machineries involved in biological phenomena, for example, large protein complexes and organelles; to identify pathogens and determine their structures in complex with cognate interaction molecules; to search efficiently lead compounds for structure-based drug discovery processes; and to create advanced technologies required for such studies.

Research Supervisor’s Policy on Call for Application, Selection, and Management of the Research Area

This CREST Research Area aims to extend Japanese research traditions in structural biology and to tackle important problems in the life sciences by creating a novel “structural life science” approach, which represents a new research discipline that integrates a wide range of bioscience subjects with next-generation structural biology methods. This Research Area also aims to promote translational research by shifting the focus of structural biology from “solving protein structures” for structure’s sake to “using protein structures” where protein structural information will be applied to practical life science problems.

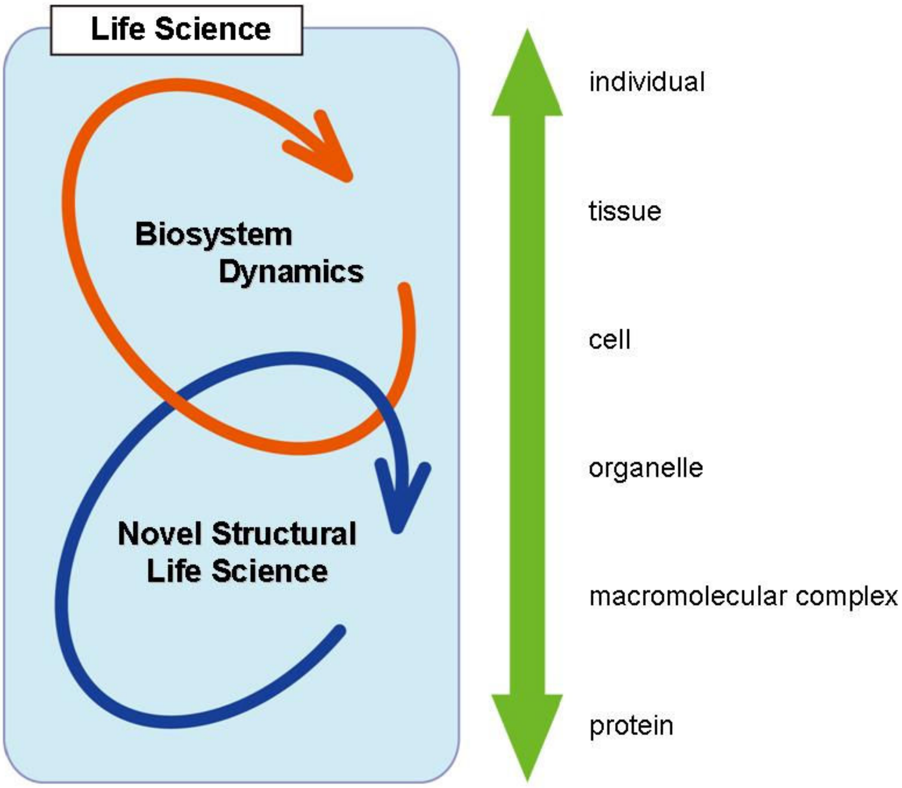
To promote ever more efficient protein structural determination; i.e., “solving protein structures”, this Research Area aims to create and develop new advanced structural biology technologies, including crystal structure analysis, solution scattering, nuclear magnetic resonance, electron microscopy, single molecule observation, cell imaging, single particle structural analysis of protein complexes, mass analysis, computational science, bioinformatics, and various other approaches for the biophysical analysis of molecular interactions. In addition to research proposals using novel applied methods, multidimensional research methods are also encouraged.

- The primary research objective focuses on structural and functional studies of proteins and their complexes with nucleic acids, lipids, or carbohydrates. This CREST Research Area targets fundamental and applied studies of molecular mechanisms underlying biological phenomena that are common to prokaryotes and eukaryotes.
- Proteins undergo spatiotemporal changes induced by biomolecular interactions/modifications or small molecules. This CREST Research Area aims to elucidate these molecular changes through a hierarchical understanding of the structural changes from the atomic to the cell and tissue levels. It also encourages the development of novel synthetic routes to create innovative small molecules that can control molecular mechanisms and various pathways. Together, these tools will allow the determination of protein dynamics and functional mechanisms underlying protein–protein interactions and other macromolecular complexes.

Using a structural life science approach; i.e., "using protein structures", this CREST Research Area seeks to analyze the dynamics of important functional machinery involved in biological phenomena, to identify pathogens and determine their structures in complex with cognate interaction molecules, to efficiently identify lead compounds for structure-based drug discovery processes, and to create the advanced technologies required for such studies. It also encourages the establishment of novel technologies to synthesize innovative small molecules that can control various molecular mechanisms. With respect to the translational and practical use of protein structures, this Research Area focuses on basic research proposals with clear roadmaps to commercial applications. Such topics could include the development of food additives to improve food safety, new examination/prevention/treatment approaches for bacteria or viruses that are associated with food poisoning, eco-friendly plant cultivation, and biofuel production.

In order to emphasize these guidelines, priorities will be given to research teams that include a structural biologist. Estimated budgets are projected to be 200–300 million yen, according to the size of the research team. A budget over 300 million yen will require justification.

This CREST Research Area emphasizes collaboration not only across CREST grant recipients, but also with participants in the Precursory Research for Embryonic Science and Technology "Structural Life Science" and the Ministry of Education, Culture, Sports, Science and Technology "Platform for Drug Design, Discovery and Development" projects, which were launched at the same time. Accordingly, we will foster a broad coordination and cooperation with other related projects by providing frequent opportunities for cross-fertilization of ideas relating to life science research and structural biology. We hope that this will lead to new ideas and collaborative research.



4.2.6 "Structural life science and advanced core technologies for innovative life science research" <PRESTO>

Research Supervisor: Soichi Wakatsuki (Professor of Photon Science, SLAC National Accelerator Laboratory, USA / Professor of Structural Biology, School of Medicine, Stanford University)

__Outline of Research Area__

This Research Area aims to integrate cutting-edge life science research with advanced core technologies in structural biology to create a new research field, "structural life science" which will lead to innovation in life science. It will address fundamental problems in life science by seamlessly integrating advanced methods of structural analysis and establishing general principles for elucidating and predicting the dynamics of hierarchical structures ranging from the atomic level to the cellular or tissue level.

This PRESTO covers the following research areas with a particular emphasis on proteins because of their essential roles in molecular recognitions in wide ranging biological phenomena:

1) Elucidation of molecular mechanisms of biological functions or control thereof through hierarchical understanding of protein-protein interactions, interactions of proteins with other biological macromolecules such as nucleic acids or lipids, or spatiotemporal changes of higher-order structures caused by endogenous/exogenous small molecules or post-translational modifications of proteins including glycosylation, ubiquitination, phosphorylation, and methylation.

2) Molecular control or design of macromolecular complexes using chemical biology or other novel methodologies.

3) Development of novel technologies for structural and functional analyses with variety of spatiotemporal resolutions and physiological conditions (from in vitro to in vivo). Applications included in this endeavor are crystal structure analyses, solution scattering, nuclear magnetic resonance, electron microscopy, cell imaging, mass spectroscopy, computational science, bioinformatics, and various biophysical analyses of molecular interactions.

4) Novel correlative structural analysis methods, or integrated structural biology, that correlates a number of complementary techniques in a synergistic manner to study hierarchical dynamics of biological molecules and their complexes, organelles, cells and tissues, involved in important biological functions.

To achieve these objectives, we encourage original research proposals on challenging problems in life science by using cutting-edge structural biology approaches as well as those which aim to develop novel structural biology methodologies to address important questions in molecular cell biology, medicine, or pharmacology.

Research Supervisor's Policy on Call for Application, Selection, and Management of the Research Area

Structural biology research is a branch of science to study complex biological mechanisms through elucidation of the three-dimensional structures of biological molecules such as proteins, nucleic acids, and lipids and their complexes. Recent progress of the structural analysis methods as well as their integration with chemical biology have been instrumental in advancing our understanding of biological phenomena. In particular, structural information of three-dimensional structures of proteins implicated in a number of diseases, food safety, and environmental science is expected to contribute to drug discovery or novel industrial applications. However, for structural biology to play an even larger role in future life science, it has to reach a higher level of integration with the relevant science areas in order to elucidate intra- or extracellular biological phenomena caused by dynamic interactions and changes in higher-order structures of biological macromolecules and their complexes. For this purpose, the integrated structural biology approach described above will be important for studying spatiotemporal dynamics of hierarchical structures that underlie biological phenomena by seamlessly integrating various analytical methods that differ in spatiotemporal resolutions and sample environments (from in vitro to in vivo). In addition, establishing a new set of general principles will be required for predicting interactions among biomolecules, especially with respect to the interaction surfaces and structural changes of individual components during the interaction. The research goals described above require genuine integration of structural biology and cutting-edge research in life science. While structural biologists must have a deep understanding of and commitment to their target areas of life science, life science researchers may obtain much higher-level knowledge by applying structural approaches to their own research areas. It is expected that the new "structural life science" based on such interdisciplinary integration will allow us to "see and understand biological phenomena at the atomic level, and apply them to address the societal needs" and lead to further innovation in life science.
In this second application cycle we will place emphasis on

(1) Collaboration between life science research and technologies for structural and functional analyses
(2) Research proposals in food and environment sciences

(3) Integrated structural biology approach including NMR, chemical biology and vibrational spectroscopy

in part reflecting and balancing with the expert areas of the eleven PIs selected in the first cycle. This is to further strengthen the mission of this PRESTO Research Area, Creation of new technologies for breakthroughs in understanding and predicting biological activities and intermolecular interactions by means of novel "Structural Life Science", that would contribute to new medical treatments and prevention of various diseases, food safety enhancement and environmental improvement.

Although JST's PRESTO projects' main objective is to promote science of individual researchers, the Structural Life Science Research Area welcomes proposals with a clear vision and roadmap on how his/her research plan links to interdisciplinary collaboration, in view of the underlying theme of this strategic goal “structural life science,” which aims to integrate life science and structural biology. A successful research project should therefore include an outline of the intended collaboration with a research team comprising part of the CREST “structural life science” research area, launched at the same time and with the same strategic target, or the Ministry of Education, Culture, Sports, Science and Technology “Platform for Drug Design, Discovery, and Development,” which started in the fiscal year 2012.

In view of the aim of integrating life science and structural biology research, this PRESTO Research Area will foster coordination and cooperation not only within the Research Area but also with other related projects by providing frequent opportunities for cross fertilization of life science research and structural biology, which, we hope, lead to new ideas and collaborative research.

Research Area in the Strategic Object:
"Creation of the basic technologies for disease analysis and elucidation of stem cell differentiation mechanisms by using epigenomic comparison toward the realization of treatments and regenerative medicine used to prevent, diagnose, and treat diseases"

4.2.7 "Development of Fundamental Technologies for Diagnosis and Therapy Based upon Epigenome Analysis" <CREST>

Research Supervisor: Masayuki Yamamoto
(Professor, Graduate School of Medicine, Tohoku University)
Deputy Research Supervisor: Toshikazu Ushijima
(Deputy Director, National Cancer Center Research Institute)

Outline of Research Area

For healthy life and development of novel strategies for disease prevention, diagnosis, and therapy, this research area focuses on discovery of new principles and establishment of fundamental medical technologies based on epigenome analyses accompanied by biological analyses.

Specifically, this research area invites proposals that identify epigenome alterations useful for identification of etiologies or those critically involved in development and progression of cancers or other chronic disorders, such as arteriosclerosis, diabetes, neurological diseases, and autoimmune diseases. The findings should lead to identification of novel mechanisms for induction of epigenome alteration or maintenance of epigenomes or to innovative strategies for disease prevention, diagnosis, and therapy. This area also invites proposals that, by comparing epigenome profiles during stem cell differentiation, reveal mechanisms of cellular differentiation and establish technologies for robust directed differentiation of various cells to specific lineages. Furthermore, this area invites proposals that develop key technologies for more efficient analysis of methylomes and histone modifications, and for control of epigenomes.

In this research area, JST cooperates with the International Human Epigenome Consortium (IHEC) through some proposals.

Research Supervisor's Policy on Call for Application, Selection, and Management of the Research Area

Completion of the human genome project has advanced our understanding of diseases from genetic aspects. At the same time, it is now recognized that genes utilized are different depending upon tissue types and cellular differentiation stages, and that epigenetics play a key role in the regulation. It has been indicated that epigenomic alterations induced by environmental and other factors play important roles in pathogenesis of diseases, especially cancers. Recently, epigenomic analysis has been conducted in many disease fields, such as psychiatric, neurodegenerative, metabolic, and allergic diseases, in addition to cancers.

Nevertheless, basic and fundamental knowledge on what epigenome each cell type physiologically has, how extrinsic and intrinsic factors affect epigenomic statuses, and how epigenomic statuses affect cellular function, has not been fully elucidated. To utilize epigenome research for development of novel strategies for disease prevention, diagnosis, and therapy, it is essential to make a solid foundation by comprehensive analysis of methylomes, histone modifications, non-coding RNAs, and chromatin complexes in appropriate cell types. It is also important to clarify what epigenomic changes are induced during differentiation and reprogramming, what epigenomic alterations are present in cells affected by a disease, and what functional consequences are induced by such epigenome alterations.

For evaluation of proposals, this research area continues to place emphasis on (1) the prospect of clinical application, (2) the potential to bring a breakthrough to epigenome research, and (3) the effectiveness of the CREST funding, as in FY2011 and FY2012. At the same time, since this request for proposals in FY2013 is the final one, this research area will place strong emphasis on the portfolio of ongoing projects and new proposals. For proposals of research on diseases, for example, proposals on metabolic and endocrine disorders, autoimmune and allergic disorders, for example, are especially welcome. For proposals that aim to elucidate a principle or mechanism of epigenetic processes, proposals that do not overlap with already selected projects are welcome. Proposals with research budgets of 150 million yen to 300 million yen are prioritized.

Please note that this year proposals that aim to pursue standard human epigenomes and contribute to the IHEC are not invited.

Research Area in the Strategic Object:
"Creation of the technology systems to have absolute control of cells and cell populations by reproducing cell kinetics in silico/in vitro in order to achieve an integrated understanding of life phenomena and realize safe and highly effective treatments among other benefits"

4.2.8 "Creation of Fundamental Technologies for Understanding and Control of Biosystem Dynamics" <CREST>

Research Supervisor: Tadashi Yamamoto
(Professor, Okinawa Institute of Science and Technology (OIST))

Outline of Research Area

Living organisms are in dynamical balance between their responses to environmental stimuli and their ability of maintaining homeostasis. Through observation, experimentation and measurement of biological phenomena conducted by macromolecules including chromosomes, proteins, and lipids at levels of cell-free system, cells and cell populations, the researches of this research area is expected to gain an integrated understanding of dynamical balance of the living organisms in both spatial and temporal dimensions. At the same time, the research of this research area aim to create technologies that can control biological phenomena.

The research should elucidate an operating principle of dynamic and complex biological phenomena that has been hard to address by traditional approaches. To do so, the research needs to utilize rapidly growing high-speed/super-resolution technologies for measurement/analysis, and to integrate life sciences with cutting edge fields of mathematics, physics, chemistry, engineering, information science and computer sciences. We promote leading researches with interdisciplinary views for comprehensive understanding of dynamic systems of the living organisms using modeling and simulation based on mathematical science.

Research Supervisor's Policy on Call for Application, Selection, and Management of the Research Area

Various disorders may result from inadequate regulation of biological phenomena such as reproduction, generation of cells, development of neural networks, immunity, and stress response. In most cases, "Operating principles," which are the foundations of exquisite regulatory systems, are conserved in various organisms. This research area aims to clarify the operating principles of spatiotemporal biological phenomena using experimental and theoretical approaches and consequently promote research on "biodynamics", enabling control and design of the regulatory mechanisms governing biological phenomena.

In recent years, many pioneering researches have examined the nonlinearity of biological phenomena and their functioning within biological systems. Studies using large spatiotemporal datasets obtained from live-imaging, genome sequencing, metabolome/proteome/transcriptome analysis have been conducted in various 'omics' fields. However, further mathematical studies using theoretical and modeling approaches are required to provide experimental verification for understanding the universal operating principles of biodynamics within an advanced hierarchy from molecule to individual. Therefore, biodynamics may be expressed quantitatively using mathematics such as differential equations, probability statistics, topology, and geometry as a prerequisite. Furthermore, state-of-the-art high-performance instruments may be utilized preferably to analyze biodynamics and to verify the results of mathematical approaches. This constructive (or synthetic) approach may be practical for elucidation of biological operating principles. It may also result in exploitation and development of new mathematical theories and more advanced high-end technological developments.

Based on the above backgrounds, I welcome research proposals focusing on mathematical trials that approximates and expresses the nonlinearity and the hierarchy of a biological dynamics. And each research is expected to be influential in the field of life science in the twenty-first century.

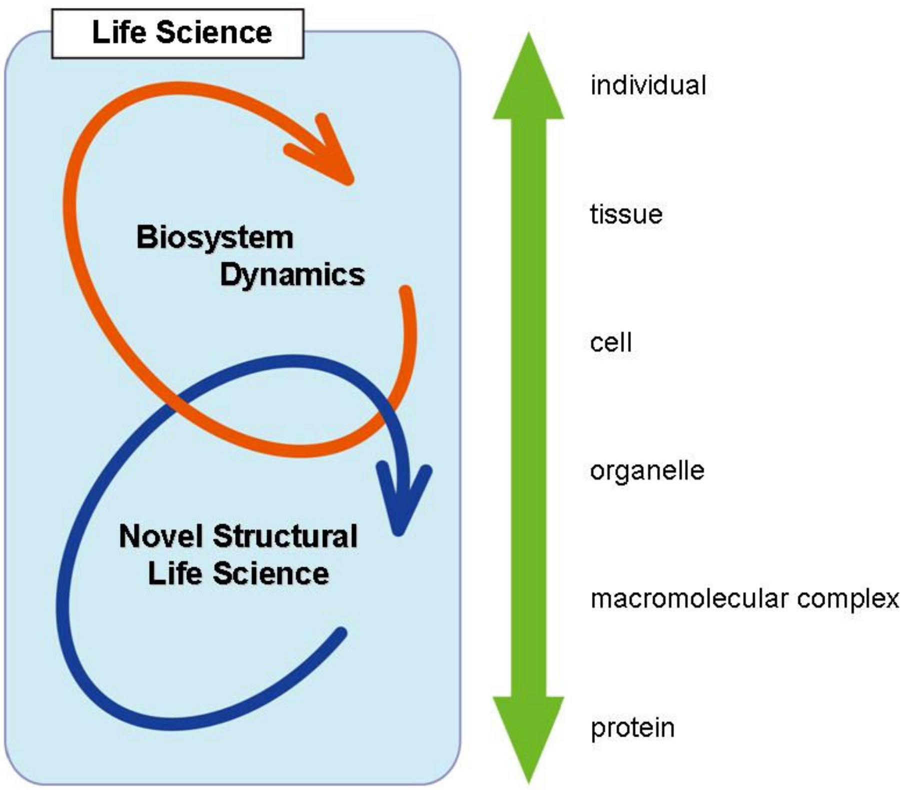
The following points should be included in the research proposal:

- Outline of the grand design of the research cycle from the experimental stage to verification of results through modeling and prediction.
- The research team is encouraged to include and cooperate with representatives from both the experimental sciences (including engineering and instrumental development) and the theoretical sciences.
- The proposed research is expected to involve development of new concepts in the life sciences, more advanced and high-end technological development, or exploitation and development of mathematical theory.
- The outcome and targeted biological phenomenon are desirable to contribute to breakthroughs in basic science, medical science, drug design, or environmental sciences.

In addition, although the strongest emphasis is placed on the criteria listed above, other unique research proposals that focus on increasing our understanding of the control or design of biological phenomena are also eligible.

The operating structure of the present research area involves collaboration with the PRESTO research area "Design and Control of Cellular Functions" (Research Supervisor: Hiroki Ueda, Group Director, Quantitative Biology Center (QBiC), RIKEN), which shares the same strategic object, to advance research effectively and efficiently.

* The figure below illustrates the difference in research themes between the present research area and the CREST research area "Structural life science and advanced core technologies for innovative life science research" (Research Supervisor: Keiji Tanaka, Director, Tokyo Metropolitan Institute of Medical Science).



4.2.9 “Design and Control of Cellular Functions” <PRESTO>
Research Supervisor: Hiroki Ueda (Group Director, Quantitative Biology Center (QBiC), RIKEN)

Outline of Research Area

In this area of research, we seek to gain insights into the principles of living systems through the design and control of cellular functions. Toward this end, we will seek to establish new concepts and technologies with broad applications. In particular, this research will address, but not be limited to, the following areas:

1) Logical (or efficient) design and control of biomolecules involved in cellular functions

2) Reconstitution and design of processes that support the infrastructure of cellular function (e.g., genomes, metabolic networks, cell-free translation systems, cell membrane division)

3) Reconstitution, design, and control of processes that implement higher-order cellular functions (e.g., signal transduction, gene network, intercellular communication)

4) Reconstitution, design, and control of populations of cells, tissues, organs, and individual organisms.

5) Construction of a framework for the implementation of open innovation toward the design and control of cellular function unifying diverse fields, such as chemistry, physics, information science, engineering and life science

This field of study covers not only creative basic research projects based in unique concepts, but more ambitious applied researches, which may advance medicine and solve energy problems, as well.

Research Supervisor’s Policy on Call for Application, Selection, and Management of the Research Area

In its quest to answer the question “What is life?” the life sciences have been advancing rapidly with the discovery of various biomolecules and through analysis of their functions. More than 10 years have passed since decoding of a series of important genomes, including that of the human, around the year 2000. As a result of this catalogue of genetic information (the genome) becoming available, developments based on the analysis of individual biological phenomena have accelerated our understanding of the blueprints of the cell, the fundamental unit of life. Among these developments, in vitro reactions of biomolecules have already aided in the successful reconstruction of intracellular phenomena such as replication, transcription, and translation. This type of constructive approach is in its infancy, but even before now, diverse and deep expertise has been acquired on how biomolecules generate cellular functions. Through testing, reconstitution, design and control of cellular functions, opportunities to gain further insight into the design principle of cells have increased both in Japan and overseas. Accordingly, the purpose of this field of study is to establish new trends in the life sciences that may help to advance our understanding of life and provide broad applications through a broad-ranging constructive approach, from molecule design to the composition of non-human embryos.

A constructive (or synthetic) approach encompasses a qualitative understanding of molecular networks and defining sufficient conditions for molecular networks to function. This also differs from the descriptive (or analytical) approach, which emphasizes data collection, in taking an alternative approach that places greater importance on the quantitative predication and verification of the dynamic behavior of biological systems, which also has the benefit of driving forward a cycle of theoretical and experimental development. Furthermore, a constructive approach requires the formularization and quantification of various phenomena, and, through performing experimental verification of theoretical prediction, makes clear the discrepancies between the targeted biological functions and current knowledge and theory. Such discrepancies give rise to new areas for further research, and serve to prompt deep questioning and understanding of the target phenomena, and ultimately we hope, full control over them.

Recently, a larger theme involving the unification of this kind of constitutive approach, namely, “reconstruction and design of cell”, has come to be actively discussed both in Japan and overseas. These discussions enforce a constant awareness of the research problem at hand, namely, how do we know whether “cells” are created? It also leads to continuous and active discussion about the fundamental questions in life science, such as “What is a cell?” and “What is life?” For that reason, a constructive approach takes not only a natural science perspective, but also takes into account social and cultural involvement.

The size of DNA sequences that can be synthesized is increasing exponentially. To date, the DNA sequence of gene size and virus size have been fully synthesized, and last year in 2010, synthesis of the bacillus genome was accomplished. If the development of DNA synthesis continues at this pace, it may become possible to synthesize genomes the size of the human genome by 2015-2020. What kind of developments in life science will be possible at that point? It is hoped that the birth of "synthetic" life science can be witnessed through participation in this field of study. In this research area, the following two criteria (either one or both) on the part of candidate research proposals have been selected for emphasis:

1) an interest in trying to address scientific questions through the design and control of biological systems; and

2) the importance of basic techniques (and frameworks) for attempting to implement and promote the design and control of biological systems.

We welcome original individual research proposals satisfying either criterion, as well as proposals from not only researchers in life science, but also those in physics, chemistry, engineering, information science, and social science. In the case that multiple fields of expertise are needed to realize the research objectives, we welcome PRESTO research projects that aim to link with researchers from other fields than the applicant's. (Please specify the expertise and roles of the applicant and the party/parties with whom the applicant seeks to have links).

We received a number of research proposal applications during FY2012. We have accepted a wide variety of proposals, including those with the following three subject areas: (1) understanding interesting biological phenomena with a constructive approach, (2) development of techniques and methods for the design and control of cellular functions, and (3) development of techniques and methods for the foundation of synthetic biology and regulatory biology. Please refer to the following points if you plan to re-apply using the submitted projects or with new projects:

1. We are looking for research proposals that extend beyond the mere “description” or “identification” of factors in biological phenomena. We strongly recommend that applicants consider their research plans from a more constructive perspective, according to their experience.

2. If the project theme is related to innovative and advanced technology development, please describe in detail “what” the new technology facilitates and “how” it leads to a better understanding of biological phenomena and cellular functions.

3. Research proposals and plans would be more persuasive if they contain preliminary data, supporting your working hypothesis, or the readiness of the experimental techniques.

4. Major areas that are expected to develop in the future are synthetic and regulatory biology of biological phenomena at organism levels, or life science research which is initiated from theory and information. However, we were unable to accept sufficient number of proposals in these areas during the last fiscal year. We recommend that you consider the submission of any future proposals that fall under these areas.

4.3 Information and Communication Technology

Research Area in the Strategic Object:

Creation, advancement, and systematization of innovative information technologies and their underlying mathematical methodologies for obtaining new knowledge and insight from use of big data across different fields

4.3.1 "Advanced Application Technologies to Boost Big Data Utilization for Multiple-Field Scientific Discovery and Social Problem Solving" <CREST>

Research Supervisor: Yuzuru Tanaka

(Professor, Graduate School of Information Science and Technology, Hokkaido University)

Outline of Research Area

Along with the penetration of ICT in society and the advance and spread of sensors, measurement instruments and observation equipment for gathering information in the real world, the amount of data obtained from various fields has grown exponentially and continues to become more diverse. Advanced integration and use of big data are expected to bring about science and technology innovation and the creation of intellectual value through new scientific discoveries, with development of the resulting knowledge leading to creation of social and economic value as well as improvement and optimization of services.

In this research area, studies will be carried out in cooperation with information science and mathematical science field, and various research fields (application fields) in which the use of big data can bring about a great social impact. In order to make scientific discoveries, solve challenging social and economic problems and achieve innovative value creation, large-scale and diverse relevant data which could not be accumulated by individual researchers or organizations will be mutually related and subjected to a high level of integrated analysis. In this way empirical research and development will be carried out on extraction and creation of the innovative knowledge and value that are hidden in big data. To this end the research area will aim for the empirical creation and sophistication of the necessary next-generation application technologies.

Specifically, by means of innovative technologies for high-level integration and use of big data, the research will empirically realize innovative value creation, solutions to challenging social and economic problems, and/or various scientific discoveries in areas such as life science, materials science, health and medical care, society and economy, urban infrastructure systems, disaster prevention and mitigation, agriculture, forestry and fisheries industry, outer space, and the earth's environment. The purpose is not simply creating knowledge and value by applying existing core technologies. Rather, the aims are new empirical creation and sophistication of next-generation application technologies necessary for achieving the objectives, and establishment of comprehensive and integrated big data analytics system technology adapted to the characteristics of application fields.

Moreover, in this research area collaboration will be encouraged with the related research area, Advanced Core Technology for Big Data Integration, including the sharing and use of next-generation core technologies developed in that area.

Research Supervisor's Policy on Call for Application, Selection, and Management of the Research Area

(1) Background

The development of the Internet and mobile devices, and the growing capabilities and spread of sensors and of measurement and observation instruments, have resulted in the accumulation of enormous amounts of data of various kinds on a global scale. The pace of this accumulation is becoming ever faster, bringing us to what is being called the era of “big data.” The availability across organizations and fields of diverse and large-scale relevant data possessed by different owners can be expected to enable the creation of innovative knowledge and value that could never be derived from individual data alone. For fostering new research and development methods using big data in a variety of application fields, measures are needed that will facilitate the collection and sharing of the above-noted relevant data in its communities. At the same time, recent years have seen a surge in research and development of individual algorithms, mathematical techniques, and software tools for analyzing and visualizing big data; and the number of different types has also grown dramatically. When we have the diverse big data relevant to scientific discovery or to actual challenging social and economic problems, there have been almost no scientific or engineering studies on the comprehensive methodology, or adequate accumulation even of experiential knowledge, regarding what combination of tools and techniques or what procedures for analysis and visualization will lead to problem solution. Further creation and development of this field, called data science, will be needed from scientific and engineering standpoints.

(2) Research requirements

In this research area, large-scale and diverse relevant data which could not be accumulated by individual researchers or organizations will be collected across fields and organizations, then mutually related and subjected to a high level of integrated analysis, for the purpose of conducting empirical research and development on extraction and creation of the innovative knowledge and value that are hidden in big data. It will not be sufficient to aim for creating some kind of knowledge and value by applying known algorithms and mathematical methods to big data in a given application field. It will be necessary in the course of this research and development to aim for new empirical creation, sophistication, and systematization of the next-generation application technologies and system technologies needed for achieving the objectives. For analysis of big data in actual application fields, an important factor will be how innovative techniques are able to support repeated trial-and-error exploratory analysis and visualization, freely using many different types of tools together. Analysis scenarios combining various element technologies will be needed for this purpose.

As research themes, we expect that healthcare-related big data analysis, already being carried out in Europe and the United States, and other application fields that should receive national focus, will be uncovered. Efforts should also be made to educate data scientists through the empirical research, and to extract know-how from a scientific and engineering approach and elevate it to reusable knowledge.

With regard to the handling of data that may be subject to personal information protection, proposals with legal considerations and system design compliant with these will be welcomed.

(3) Research Group Composition

This research area will be administered as a team-based CREST research program. A research team like the following is assumed in this research announcement.

- The team must consist of one or more researchers in fields aiming for scientific discovery or for solutions to social and economic problems, and one or more mathematicians and/or researchers in information engineering and computer science.
- The team does not have to include big data owners but the latest big data associated with real problems must be always available and must be able to be updated. Researchers who are experts in the target field and can interpret the meaning of real data and its analysis results, must be included in the team.
- We expect the team to actively incorporate social scientists and economists that are required to solve problems. Especially if data that may be subject to personal information protection is shared or

distributed in the team, the rules and conforming system for data sharing and distribution should be designed jointly with legal experts, and using special zones or the like should be considered.

- Outsourcing to external agencies should be avoided as much as possible, since the research area aims to research and develop innovative technologies with empirical analysis comprehensively over the entire course of its processing..
- We also expect the team to collaborate with the enterprises in order to encourage the rapid transfer of research results to society.

(4) Collaboration with other research areas

We will promote the synergy between this research area and CREST/PRESTO Combined Area " Advanced Core Technologies for Big Data Integration " (hereinafter CORE) set up at the same time with the same strategic goals, and promote the matching of domestic and overseas researchers. Specifically, administration will be carried out along the following lines.

- Area conferences and workshops will be held jointly between this research area and the CORE research area, in this and other ways closely sharing information among researchers from diverse fields.
- To the extent possible, data and technologies will be shared with and provided to the CORE research area.
- Utilization of the common core technology created in CORE research area will be encouraged. It is possible that participation of people from CORE research area will be accepted as a CREST joint research group.

In addition, collaboration with overseas researchers and projects will be actively carried out. In preparation for the call for proposals next fiscal year or following, workshops and the like will also be held for researchers in various related fields in Japan and abroad and information science and computer science researchers as well as mathematicians, regarding the application fields to receive special emphasis. Thereby, we lay the groundwork that will enable teams to be formed across fields for applying for the program.

4.3.2 “Advanced Core Technologies for Big Data Integration” <CREST & PRESTO>
Research Supervisor: Masaru Kitsuregawa (Director General, National Institute of Informatics)

<u>**Outline of Research Area**</u>

Along with the penetration of ICT in society and the advance and spread of sensors, measurement instruments and observation equipment for gathering information in the real world, the amount of data obtained from various fields has grown exponentially and continues to become more diverse and more frequent in occurrence. Advanced integration and use of big data are expected to bring about science and technology innovation and the creation of intellectual value through new scientific discoveries, with development of the resulting knowledge leading to creation of social and economic value as well as improvement and optimization of services.

This research area will aim for the creation, advancement, and systematization of next-generation core technology solving of essential issues common among a number of data domains, and integrated analysis of big data in a variety of fields.

Specific development targets include technology for stable operation of large-scale data management systems that compress, transfer, and store big data, technology for efficiently retrieving truly necessary knowledge by means of search, comparison, and visualization across diverse information, and the mathematical methods and algorithms enabling such services. In pursuing these studies, with a view to overall system design up to the creation of value for society from big data, the creation, advancement, and systematization of next-generation common core technology highly acceptable to the public will be undertaken, through active efforts at fusion with fields outside of information and communication technology.

Moreover, in this research area collaboration will be encouraged with the related area, "Advanced Application Technologies to Boost Big Data Utilization for Multiple-Field Scientific Discovery and Social Problem Solving," such as by sharing and use of the next-generation core application technology and data obtained in that research.

Research Supervisor's Policy on Call for Application, Selection, and Management of the Research Area

(1) Background

Global megaservices like Amazon, Google, and Facebook have led the way in building the massive-data processing infrastructure that has given birth to what is being called the era of big data. This can also be seen as the creation of the world view of which the new large-scale data infrastructure became the enabler. Even apart from business, the important role played by large-scale data in scientific discovery is recognized in sciences such as high energy physics, genome research, and astronomy. Science based on large-scale data is positioned as the fourth science (e-science), and is even included in the 4th Science and Technology Basic Plan of the Japanese government, as it continues to gain notice. In the big data era, the building of data infrastructure itself is becoming a lifeline of science. There are major expectations for massive data also in research in such areas as heretofore incurable diseases and rare species, since it enables analysis of the "long tail" which had not been undertaken until now.

In the United States, big data is seen as having a potential of exerting a great impact on science, industry, and society comparable to that of supercomputers and the Internet; and R&D policy measures are being developed in many government agencies. This research area seeks to ensure that leading-edge research toward the big data era is carried out in Japan as well.

(2) Research requirements

The target of this research area is core R&D for the big data era that is expected to develop in a major way in the future. Even with the emphasis on core technology, however, proposals are expected to assume applications to a certain degree, since carrying out technology development without having any applications in mind makes it difficult to set performance axes. Rather than new technologies giving birth to services, the trend lately has been for services to drive technology. It would therefore seem only natural for proposals to include evidence that the core information technology is valid in a number of application areas. On the other hand, research that is more specifically geared to application development should be proposed in the research area, "Advanced Application Technologies to Boost Big Data Utilization for Multiple-Field Scientific Discovery and Social Problem Solving" It is possible that in some cases there will be cross-over between the areas from the standpoint of balance between the two.

The contents of core information technology are many and varied. Proposals are expected to cover a variety of technology innovations that might be seen as necessary for the coming era of big data. Studies will be welcomed that cover infrastructure technologies, such as large-scale data management, compression, suppression, anonymization, metadata assignment, data forgetting, cloud architecture technology, power awareness, lineage, crowdsourcing, etc., as well as machine learning in diverse domains, analytical techniques, visualization techniques and visual interaction, and tools to assist in digesting the obtained analytical results, in addition, studies on the acceptability of big data solutions to society, stakeholder coordination, and mechanism design. Also welcome are proposals that address the lack of clarity of current laws regarding permission to use data, by making the public aware of the problems with existing laws and demonstrating the overwhelming benefits that use of big data will bring.

As computer resources, rather than purchasing equipment, use of the cloud to the extent possible is preferable.

(3) Research Group Composition

This research area adopts a hybrid approach, being administered both as a team-based CREST research program and as an individual-research PRESTO program, under the supervision of one person. As area advisors it is planned to invite people from information science and mathematical science as well as from the industrial world, along with experts in legal systems. Taking advantage of the team format of CREST, element technologies will be integrated and undertaken comprehensively with a view to operation and practice in real society. In the PRESTO program, seminal and ambitious research based on concepts that break with the past will be undertaken, aimed at next-generation core technologies. Specifically, administration of the research area will be carried out emphasizing the following points.

- The CREST research is expected to be carried out by a team of scientists, led by a researcher from the information science or mathematical science field. The PRESTO research will be carried out by an individual researcher from the information science or mathematical science field.
- The CREST research is in principle to last 5.5 years, but it is possible that the research schedule will be shortened to around three years based on the interim evaluation.
- In order to encourage the rapid transfer of research results to society, a joint research organization incorporating private corporations in the team will also be welcomed.

(4) Collaboration with other research areas

We will promote the synergy between this research area and the CREST area, “Advanced Application Technologies to Boost Big Data Utilization for Multiple-Field Scientific Discovery and Social Problem Solving” (hereinafter “APPLI area”) set up at the same time with the same strategic goals, and promote the matching of domestic and overseas researchers Specifically, administration will be carried out along the following lines.

- Area conferences and workshops will be held jointly between this research area and the APPLI area, in this and other ways closely sharing information among researchers from diverse fields.
- Sharing and provision of data and technologies from the APPLI area will be actively accepted.
- The common core technology created in this research area will be actively deployed in the APPLI area. Participation in the APPLI area as a CREST joint research group is also conceivable.

In addition, collaboration with overseas researchers and projects will be actively carried out. In preparation for the call for proposals next fiscal year or following, workshops and the like will also be held for researchers in various related fields in Japan and abroad and information science and computer science researchers as well as mathematicians, regarding the application fields to receive special emphasis. Thereby, we lay the groundwork that will enable teams to be formed across fields for applying for the program.

Chapter 5 Strategic Objects

5.1 Green Innovation

5.1.1 Creation of core technologies for innovative energy carrier utilization aimed at the transport, storage, and use of renewable energy

Targets to Achieve:

Technologies are to be created for highly efficient conversion and use of nitrogen compounds, hydrocarbons, inorganic hydrides or other substances suitable for use as energy carriers (carriers that transport and store energy) in terms of their hydrogen content, low environmental impact, ease of use, etc., in preparation for the coming widespread use of hydrogen energy. To this end the program aims to achieve the following targets.

○ Creation of core technology for efficient conversion of renewable energy to chemical energy (energy carrier)
○ Creation of core technology for generating electrical energy from the energy carrier
○ Creation of technology for safe transport and storage of energy carriers

Vision for Reaching Achievable Important Goals in the Future:

Research achievements in this strategic object that are aimed at achieving the objectives in "Targets to Achieve" will make it possible to establish core technologies for the safe transport and storage of energy carriers and enable use for electrical power or motive power or as raw materials for chemical products, as needed, while replacing the various energy carriers with photovoltaic, wind power and other renewable energies. These research achievements will be provided to private sector companies; moreover, they will be used for load leveling of renewable energies in Japan in order to establish a new use mode for renewable energies that is not dependent on the power grid. This will help to enable renewable energies to be used actively in a stable manner and create a system that helps bring about the arrival of the widespread use of hydrogen energy in society.

Moreover, use of the technologies obtained in this strategic object and export of these technologies to foreign countries with large renewable energy reserves will contribute to economic growth in those countries and enable the import of large quantities of renewable energy from these countries in the form of chemical energy, thus helping to ensure the stable use of renewable energy both at home and abroad.

These efforts will help to achieve the "Diversification and decentralization of energy sources" and "Building of a stable long-term energy supply and demand structure and achievement of the world's most advanced low-carbon society" objectives noted in the 4th Science and Technology Basic Plan (approved by the Cabinet on August 19, 2011).

Specific Content:

(Background)

In order to greatly expand the proportion of renewable energy as a primary energy source that can meet Japan's domestic power demand, it will be necessary to overcome issues arising from the fact that renewable energy is a natural phenomenon. For example, the regions in which photovoltaic energy, wind energy and other renewable energies can be obtained are not uniformly distributed either domestically or internationally, and in many cases they are far away from cities and other energy consumption locations. There are great fluctuations in the quantity of energy that can be obtained according to the season and time, and there are other issues such as the mismatch in peak power demand and supply.

One way of overcoming the geographical and temporal issues unique to renewable energies might be to store energy in the reaction product of a chemical conversion that is performed using the power and heat produced by renewable energies, and to use this reaction product as an energy carrier. This would enable the safe transport and storage of energy in the form of this energy carrier, making it possible to use the energy in the form of power or motive power or as a raw material for chemical products according to need. The use of an energy carrier that made it possible to take out and put in energy for a longer period of time than fuel cells would be an effective way of equalizing the large fluctuations in the power generation load of renewable energy.

Hydrogen research conducted up to now has succeeded to some degree in establishing technologies for generating hydrogen by means of alkaline water electrolysis, although the issues of achieving high efficiency and reducing costs remain to be resolved. In terms of the full-fledged use of hydrogen energy on a widespread basis, however, major issues remain to be resolved in the area of hydrogen transport and storage. In order to transport large quantities of hydrogen, it must be cooled to -253°C and liquefied to increase the energy density, but this requires large quantities of energy and involves huge costs. Considering not only large-scale maritime transport but also the construction of infrastructure throughout cities for the supply of power to fuel cell vehicles and fuel cells for home use, it will be necessary to create technologies for the use of energy carriers that offer superior hydrogen content, low environmental load, ease of handling and so on.

(Research Theme)

In order to achieve this strategic object, creative research that is based on new and original ideas and is different from the hydrogen research that has been conducted up to now will be needed. The involvement of new researchers from fields such as catalytic chemistry, electrochemistry, materials science and process engineering will be essential. The goal will be to gather and coordinate these researchers around the same objective and combine knowledge from different fields to take on the challenge of researching new energy carriers, in order to establish core technologies for the synthesis and use of high-efficiency energy carriers that are not simply an extension of previous research. Specifically, the following types of basic research are envisioned.

*Energy conversion

1) Research into catalytic chemical and electrochemical technologies for direct and efficient synthesis of energy carriers, and elucidation of the mechanisms of these technologies

2) Research into synthesizing energy carriers using thermochemical processes that employ solar heat and geothermal heat

3) Additionally, establishment of guidelines for the creation and design of new materials that will serve as energy carriers that offer outstanding properties in terms of hydrogen content, low environmental load, ease of handling and so on, and research into ways to use photosynthesis, etc. to efficiently convert hydrogen and water into energy carriers

*Energy use

1) Research into new direct fuel cells capable of using energy carriers as fuel to extract electrical energy

2) Research into dehydrogenating technologies for extracting hydrogen from energy carriers at low temperatures with high efficiency

3) Research into new processes that use energy carriers for the direct synthesis of useful chemical products

*Safe transport and storage of energy
Research to achieve safe long-distance transport and long-term storage of each energy carrier

In the existing research areas of organic hydrides and ammonia, methods are being developed that are completely different from existing synthesis techniques. Examples include a new type of electrolytic synthesis, one that fuses electrochemistry and catalytic chemistry, to achieve direct synthesis of organic hydrides without hydrogen mediation, and an ammonia synthesis method that uses the development of a new catalyst to disassociate nitrogen triple bonds, eliminating the need to use rare metals or difficult-to-obtain reducing agents.

Policy Positioning (positioning within the policy system and necessity/urgency in terms of policy etc.):
Under the 4th Science and Technology Basic Plan, "Promotion of green innovation" is listed as one of the main pillars for achieving growth and social development in Japan now and in the future. Moreover, research and development of "hydrogen supply systems including manufacture, transport and storage" and the deployment of these systems overseas are listed under "II-3 Promotion of green innovation." In this Strategic Object, in addition to the use of hydrogen as is, research and development for the purpose of developing new technologies for the use of energy carriers that will enable the transport, storage and use of energy will be promoted on a national basis, in order to enable more multifaceted introduction and expanded use of renewable energies. These efforts will contribute to the "Realization of a stable energy supply and lower-carbon energy sources usage" "Highly efficient and smart use of energy" and "Greening of social infrastructure" objectives noted in the 4th Science and Technology Basic Plan.

The Basic Energy Plan (approved by the Cabinet on June 18, 2010) points out the importance of "Building social systems for the effective use of hydrogen energy in the medium- to long-term" and proposes the "Achievement of a new hydrogen energy society." For the time being, the goal is to "Use hydrogen derived from fossil fuels and work to ensure effective use of fossil fuels, and use hydrogen produced as a byproduct from steel plants and the like." In the future, the goal will be to "Promote the development and use of hydrogen derived from non-fossil fuel sources." To this end, the establishment of core technologies for the use of energy carriers in this Strategic Object will be indispensable.

Moreover, in the "Action Plans for Science and Technology Priority Measures 2013" (July 19, 2012, Expert Panel on Science and Technology Innovation Policy Promotion Council for Science and Technology Policy, Cabinet Office) as well, "Creation of innovative systems for energy supply, storage and transport" is listed as a key effort in the area of green innovation.

Achievements in this Strategic Object will contribute to these goals.

Coordination with Related Policies, Division of Roles, and Differences in Policy Effects:
At a joint investigative commission convened by the Ministry of Education, Culture, Sports, Science and Technology and the Ministry of Economy, Trade and Industry, the importance of collaboration by both ministries in this research and development field was recognized. While the Ministry of Economy, Trade and Industry is promoting the development of technologies for the low-cost manufacture of hydrogen from renewable energy at companies and the like, the Ministry of Education, Culture, Sports, Science and Technology is focusing on research into innovative energy carrier conversion and use technologies and the like.

The Ministry of Education, Culture, Sports, Science and Technology is pursuing research and development of energy carriers in this Strategic Object as well as through burden-sharing and cooperation with the Advanced Low Carbon Technology Research and Development Program (ALCA) of the Japan Science and Technology Agency (JST). Specifically, the efforts are as follows.

The research and development needed to achieve energy carriers can be generally divided into two phases. One is an area on which the industrial world has already focused, but for which the need for large-scale operations and the need to reduce costs pose major barriers that must be eliminated before the technology can achieve widespread use in society. These barriers cannot be overcome through the efforts of a company working alone; the establishment of a technical infrastructure through industry-academic cooperation will be indispensable. Organic hydride and ammonia fall into this category. In order to overcome these barriers, ALCA is conducting research and development that will last up to 10 years, conducted by a mixed membership team from the spheres of industry, academia and government. The objective is to serve as a bridge between the Ministry of Economy, Trade and Industry project and industry at large. Specifically, in the area of organic hydride, ALCA will conduct research and development in the areas of electrolytic synthesis, hydrogenation, dehydrogenation and organic hydride fuel cells. In the area of ammonia, ALCA will conduct research and development in the areas of thermochemical synthesis, dehydrogenation and ammonia fuel cells.

The other phase is one for which practical use is still no more than within the realm of possibility. However, if technologies for utilization can be established, this area will produce new materials capable of securing a position as new energy carriers that can outstrip organic hydride and ammonia, or technologies that can overturn our assumptions regarding what synthesis methods are achievable for organic hydride and ammonia. Work in this Strategic Object will focus on this phase.

The achievements of this Strategic Object and the research obtained by ALCA will be shared by a governing board to be established jointly by the Ministry of Education, Culture, Sports, Science and Technology and the Ministry of Economy, Trade and Industry. When promising core technologies are developed, this board will immediately pass them on to the next phase, and will otherwise serve as a liaison organization to ensure that they do not dead-end as independent projects.

Moreover, from the standpoint of creating innovative advanced spaces and gaps controlled materials (SGCM) that enable selective material storage, transport, conversion, etc., it will be important to ensure a complementary relationship between the knowledge gained in this Strategic Object and the "Discovery of new functional materials through the use of control technologies for nano-sized spaces and gaps in materials in order to achieve selective material storage, transport, conversion etc." Strategic Object established in the same year, in order to promote an effective research organization.

Scientific Justification for the Research and Development Goals (need, urgency, achievability etc. based on domestic and international research trends):

Japan is one of the countries that exports technologies relating to solar battery power plants and wind farm equipment, but its development of technologies for the import of these types of energy is almost nil. Its international "vision" plans contain little investment for research into new energy production, transport, storage and use, and therefore research from a broad view that extends from core technologies to social engineering is essential. Moreover, Japan now boasts one of the world's foremost capabilities for research and development in fuel cells as a result of progress in individual fields such as electrochemistry, catalytic chemistry, materials science and process engineering following the establishment of the WE-NET Project ("World Energy Network: International cooperation in research and development of clean energy systems with particular emphasis on hydrogen"), and the subsequent comprehensive fruition of efforts to establish concentrated research centers such as the satellite offices of the Fuel Cell Nanomaterials Center at the University of Yamanashi and the Next-Generation Fuel Cell Research Center at the Kyushu University (both of which are national universities). The basic knowledge gained through the development of basic technologies relating to fuel cells leads in many cases to research and development of energy carriers. In terms of catalysts, which are the key to the core technologies relating to energy carriers, Japan maintains an extremely high level of research in the area of reaction research, primarily materials development and organic synthesis. As a catalyst producing country, Japan is second only to the United States. This makes Japan a world leader in both basic research and industry.*[1]

By establishing energy carriers as a common objective and utilizing its world-leading scientific potential in relevant fields to further promote collaboration and the fusion of these areas, Japan can become the first country in the world to establish core technologies for energy carriers.

The United States Department of Energy (DOE) is conducting research into areas such as technologies to convert solar energy into fuel (solar fuel) and reaction catalysts. Moreover, under the EU's 7th Research Framework Programme (FP7) as well, projects are underway in the area of solar fuel and the manufacture of hydrogen using electrolysis or heat. Amidst these international research and development trends, the number of research papers on energy carriers published in Japan, China, Germany and the United States has increased in the past few years. Although Japan has maintained its fourth place position behind the U. S., China and Germany, the number of Japanese research papers is only 1/4 that of the United States and 1/3 that of China, and the gap has been increasing as compared to five years ago.*[2]

In the past, Japan has tackled research into energy carriers, primarily with regard to technologies for hydrogen use, as part of WE-NET. In the light of recent efforts by the United States DOE and the EU, however, Japan must utilize its potential (in terms of being a world leader in science in related fields) in order to overcome the geographical and temporal issues facing renewable energy, and establish technologies for the efficient conversion of renewable energies into a form that can be transported and stored, ensuring a stable supply to consuming regions.

*[1] "International Comparison of Science and Technology & Research and Development t 2011" JST Center for Research and Development Strategy, 2011.

*[2] Thomson Reuters "Web of Knowledge" (http://wokinfo.com/)

Based on the results of a search in which keywords relating to this Strategic Object were established and a search was conducted for number of original research papers between the years 2007 and 2011.

Background to Deliberations:

The need for technologies relating to the active use of renewable energies has been recognized from the standpoint of recovery from the Great East Japan Earthquake of 2011, and the Environment and Energy Unit within the Center for Research and Development Strategy of the Japan Science and Technology Agency (JST/CRDS) has begun studying this issue. Preliminary research involving interviews with knowledgeable individuals and so on was conducted to identify the technical issues that must be resolved to convert renewable energy into chemical energy and from chemical energy into electrical power for use, as well as the approach to research and development and so on. Subsequently, a detailed study team was inaugurated and a Future Strategies for Science and Technology Workshop entitled "Core Technologies for Energy Carriers for the Transport, Storage and Use of Renewable Energy" was held (on July 28, 2012). Researchers from many different fields studied specific research and development issues, methods for promotion and so on, and pursued the establishment of a "big picture" view of such issues as the following:

- Research issues involving technologies for conversion of renewable energy (or power derived from renewable energy) into energy carriers
- Research issues involving technologies for conversion between energy carriers and conversion from carriers to electrical power and motive power

The results of these studies will be compiled in the form of a strategic proposal entitled "Core Technologies for Energy Carriers for the Transport, Storage and Use of Renewable Energy" to be released in March 2013.

Meanwhile, the Ministry of Education, Culture, Sports, Science and Technology convened a joint investigative commission with the Ministry of Economy, Trade and Industry to discuss innovative technologies that the two ministries should cooperate in studying with the aim of practical implementation around the year 2030, based in part on the aforementioned JST/CRDS study. This led to the identification of "Energy storage and transport" as one such technology. Furthermore, a working group made up of representatives from the two ministries, knowledgeable individuals etc. was established beneath this joint investigative commission to discuss this technology. By February 2013, this working group had already met seven times and held ongoing discussions regarding the roles of the two ministries and the mechanism for collaboration.

The objectives for this Strategic Object will be prepared based on the results of these studies.

5.1.2 Creation of innovative core technologies by merging material technology, device technology, and nano-system optimization technology toward the realization of information devices with ultra-low power consumption and multiple functions

Targets to Achieve:

Faced with the limits to further miniaturization and integration of conventional silicon devices, this program, with the common objective of developing information devices with at least double-digit improvements in total performance(consumption power and speed) , aims to create technologies necessary for establishing a foundation of the future electronics industry, including the creation of material technology pursuing the applicability of new functional materials (core technology necessary for developing and using advanced materials and components), the development of device technology by verifying the operation of logic and memory devices employing new materials, new principles, and new structures, and the creation of nano-system* optimization technology for implementing advanced nanotechnologies, etc., and then the fusion of these various technologies. The program aims to achieve the following targets to these ends.

○ Creation of new functional materials supporting innovative devices and creation of material technologies in pursuit of their applicability
○ Creation of innovative device technologies based on logic and memory devices, etc., employing new materials, new principles, and new structures to enable ultra-low power consumption, ultra-high speed, ultra-large capacity, etc.
○ Creation of core technologies for optimal design of nano-systems by accumulation, integration, and fusion of element technologies from various fields

*In this Strategic Object nano-systems are defined as parts, equipment, or systems that accumulate, integrate, and fuse element technologies from other fields based on nanotechnology so that taken as a whole they are able to provide advanced functions that contribute to the solution of important issues, as well as being recognized by society.

Vision for Reaching Achievable Important Goals in the Future:

In this Strategic Object, the research achievements noted in the Section"Targets to Achieve," will be linked to practical application research at private sector companies, etc. to enable the development of innovative devices that use these technologies to achieve information and telecommunications devices and system components that offer ultra-low power consumption, advanced functions and multiple functions. More specifically, they will lead to the creation of the type of society described below and help to achieve objectives such as "Highly efficient and smart use of energy" "Strengthening common infrastructure for the enhancement of industrial competitiveness" "Enhancement of cross-sectional science & technology" etc. as noted in the 4th Science and Technology Basic Plan (approved by the Cabinet on August 19, 2011).

1) Creation of various ultra-low power consumption information and communication terminals, information devices etc., making a major contribution to the formation of a sustainable advanced information and telecommunications network in keeping with the age of energy conservation

2) Fusion of devices based on new operating principles to enable multifaceted applications that include touch panels, flexible displays, solar batteries and biosensors, achieving a true "Ubiquitous Society"

3) Development of end products with social added value that are in keeping with the knowledge-based society, low-carbon society, advanced information society and so on, in order to maintain Japan's international competitiveness and nurture key industries that open the way to a new industrial structure

Specific Content:

The semiconductor industry is currently facing fierce competition worldwide. In recent projections,*[1] the scale of the market in 2012 was USD 289.9 billion, just slightly down from the previous (record-setting) year. However, gradual growth is expected to continue, and this sector serves as a foundation for industrial competitiveness. For example, it is introduced in the following manner: "The semiconductor industry has a profound impact on Japanese society, economy and environment through both its 'visible impact' and 'invisible impact.'"*[2] In addition, with the full-fledged introduction of information and telecommunications technologies in the future, the quantity of information in Japan is expected to experience explosive growth (the "information explosion"). It is estimated that in 2025, 100 to 200 times the current amount of information will be exchanged over the Internet. It has been pointed out that, in order to deal with this information explosion, the number of IT units to process this information must be greatly increased, and the information throughput of each unit will increase dramatically, and the rapid increase in the power consumption of IT units in the future will become a serious problem.*[3] In addition, according to estimates by a private research institute,*[4] by 2020 the quantity of global information is expected to grow to approximately 40 zettabytes (approximately 50 times the quantity in FY 2010), and in order to process this ever-increasing information, integration and miniaturization of existing silicon devices will also become a vital trend in the future. With existing silicon devices, however, the increased power consumption of devices due to integration, the physical limits to miniaturization, the increased variations in characteristics and so on is becoming an urgent problem. The search for measures to overcome these restrictions has taken two approaches. One approach is to improve performance by employing nanoelectronics technologies, which have seen remarkable progress worldwide in recent years, in an effort to add materials and devices with new functions that are in line with existing complementary metal-oxide semiconductor (CMOS) technologies. The other approach is to achieve devices and systems based on new operating principles that go beyond conventional CMOS technologies.

Under these circumstances, rather than independent efforts to achieve miniaturization, increase speed, reduce power consumption or provide multiple functions, state-of-the-art nanotechnologies and other basic technologies are being mobilized in this Strategic Object to create innovative "seeds" with the aim of establishing the foundation for the electronics industry of the future. The specific research projects that are being conducted are shown below. In this Strategic Object, an organization must be established to enable specialists in each field (materials, devices, systems etc.) to coordinate and collaborate from the earliest stages of the project, in order to conduct strategic and agile research toward the achievement of the common goals of developing information devices that offer a double-digit or greater reduction in power consumption and a double-digit or greater increase in speed as compared to existing devices.

1) Creation of new functional materials that provide underlying support for innovative devices and development of basic technologies through the pursuit of possible applications

Examples
- Creation of measurement, analysis and processing technologies relating to the structure and physical properties of new functional materials
- Research into crystal growth, determination of functions and construction of scientific theory relating to graphene and other atomic thin films that are expected to find applications in innovative devices

2) Creation of innovative devices by means of new materials, new principles, logic devices of new structures, memory devices etc. that enable ultra-low power consumption, ultra-high speed, ultra-large integration, etc.

Examples
- Research into technologies for applying new materials and new functional materials with outstanding properties to devices
- Proposals for devices provided with new functions through integration of heterogeneous materials, etc. and proof of concepts
- Invention of innovative device architecture technologies that enable miniaturization and large integration

3) Integration, convergence and fusion of basic technologies such as those in 1) and 2) in order to create core technologies for achieving optimal nanosystem design

Examples
- Design of material structures and device structures to produce and optimize device functions and creation of computer simulation technologies
- Creation of ultra-low power consumption technologies through linkage and coordination of materials, circuits etc. at various technology layers

*[1] World Semiconductor Trade Statistics (WSTS), "WSTS Semiconductor Market Forecast Autumn 2012," November 2012.
*[2] Semiconductor Industry Research Institute Japan, "Social Science Analysis of the Impact of the Semiconductor Industry on Society, Economy and the Environment in Japan (Final Report)," July 2009.

*[3] Ministry of Economy, Trade and Industry, "Workshop on Energy Conservation and Increased Competitiveness for Information and Telecommunications Equipment."

*[4] International Data Corporation (IDC), "Big Data, Bigger Digital Shadows, and Biggest Growth in the Far East," December 2012.

Policy Positioning (positioning within the policy system and necessity/urgency in terms of policy etc.):

The 4th Science and Technology Basic Plan states that "...since information and telecommunication technologies are basic technologies in promoting energy supply, energy use, and low carbon generation from social infrastructure, R&D will be advanced with regard to next-generation information and telecommunication networks, further energy-savings for information and telecommunication equipment and system components, and technical development for optimized control of entire network systems." Moreover, under "Strengthening common infrastructure for the enhancement of industrial competitiveness," the Plan states that "R&D will be promoted into innovative common basic technologies, including basic technologies required for the development and utilization of advanced materials and components of high added-value, large market share or future growth potential. Japan has many technologies of high global competitiveness, and many basic technologies that support the utilization of high-performance electronic devices, information and telecommunications. Therefore, a strategy for appropriately opening up those technologies will be promoted."

Moreover, the "Action Plan for the Implementation of Important Science and Technology Policy Measures" (July 19, 2012, Special Subcommittee for the Promotion of Science and Technology Innovation Policy, Council for Science and Technology Policy (CTSP), Cabinet Office) lists "Innovation of energy use" aimed at achieving large-scale reductions in energy consumption as a policy issue, and establishes "Dramatic reduction in energy consumption through technical innovation" as a priority effort. In addition, the Key Issues and Efforts in the FY 2013 Priority Policy Package" (same as above) states that Japan should become the first country in the world to apply carbon nanotubes (first discovered by Japan) and graphene and other new nanocarbon materials to a variety of components and products (heat exchangers, batteries, electronic devices, composite materials etc.) to increase the industrial competitiveness of components, parts and products in a wide variety of industries and create new growth industries, and that for these and other reasons, "the application of carbon nanotubes (CNT), graphene and other new nanocarbon materials to a variety of fields and the development of technologies for commercial use" should be a priority effort aimed at increasing Japan's industrial competitiveness.

For these reasons, developing low energy consumption devices through the use of innovative materials is needed from a policy standpoint as well, in order to achieve the objectives of "Promotion of green innovation" and "Strengthening the industrial competitiveness of Japan."

Coordination with Related Policies, Division of Roles, and Differences in Policy Effects:

The achievements of efforts conducted up to now at universities and the like and existing Strategic Basic Research Programs, etc. should be actively utilized, and close coordination with related projects should be secured, in order to ensure that achievements are quickly turned into practical applications. Specifically, from the standpoint of establishing an industrial infrastructure for the electronics of the future, intellectual property relating to achievements produced in this Strategic Object should be appropriately secured, even during the period of research, and then quickly deployed in industrial-academic collaboration projects and the like as well as private sector company projects whose aim is to develop practical applications for research achievements. The framework of the Tsukuba Innovation Arena (TIA), which gathers together a wide range of researchers from industry, academia and government, and other research and development centers in particular, should be used to maximum advantage, in order to build an organization that can link basic research achievements in this Strategic Object directly to increased industrial competitiveness for Japan.

Scientific Justification for the Research and Development Goals (need, urgency, achievability etc. based on domestic and international research trends):

"A Strategy for American Innovation" which was revised in February 2011 includes the expression "acceleration of nanotechnology" among its priority items and states that there is a need for investment in nano-electronics in particular. In addition, the EU has established Joint Technology Initiatives (JTI) to provide priority support for high-risk research that requires large quantities of funds on a long-term basis, in research domains for which there is clear support from the industrial world, and this Initiative includes "nano-electronics." In China, nanotechnology research is included as a key scientific research topic for basic research sectors in the National Outline for Medium and Long Term Science and Technology Development Planning (2005 - 2020), and "Notional and principle-oriented nanodevices, nano-electronics, nano-biology and nano-medicine" are listed among the specific priority issues.

The status of Japan, based on an international comparison with various foreign countries, has been assessed as follows. "In terms of nano-electronics, Japan maintains a high level overall, but based on a comparison of activity worldwide, optimism is not necessarily warranted. Particularly in the area of nano-CMOS technology which drives the field of nano-electronics, there has been a significant drop in research and development activity on the part of Japanese manufacturers — this at a time when the establishment of research and development centers and alliances is progressing worldwide. The fact that basic research and development on the part of academia has lagged as compared to other countries is particularly serious. Unless human resources development measures and systems for industry-academia cooperation are established from a long-term perspective, ultimately Japan will be unavoidably overtaken by South Korea or China." *[1]

In the light of this situation, progress in nanoelectronics research and development in this Strategic Object that results in the achievement of more compact devices with greatly reduced power consumption and new functions will be needed in order to achieve the low power consumption systems that will be indispensable for the age of "Big Data," as well as increased competitiveness for the electronics industry and other sectors.

*[1] JST Center for Research and Development Strategy, "International Comparison of Science and Technology & Research and Development 2009, Nanotechnology and Materials Field, 2011 Edition," 2011.

Background to Deliberations:

The Future Strategies for Science and Technology Workshop sponsored in March 2009 by JST/CRDS entitled "Nano-electronics, Opening up the Next Generation: Looking Beyond 2030" reconfirmed the importance of (1) research and development of nano-electronics core technologies to get around or break through the boundaries to miniaturization and integration, and (2) the search for new materials for nano-electronics devices and demonstration of the potential for application in devices. Based on the discussions at this workshop as well, a JST/CRDS Strategic Proposal entitled "Construction of Fundamental Technologies for Nanoelectronics: Towards a technological breakthrough overcoming limitations in scaling, integration and power consumption reduction" (July 2009) was formulated, calling for the need for long-term efforts to search for new principles, structures and materials and conduct research and development of devices for their use. With graphene and other two-dimensional thin films attracting a great deal of attention, a JST/CRDS Future Strategies for Science and Technology Workshop entitled "Creation and Development of Atomically Thin Functional Films and Molecular Thin Films" was held in February 2012, at which it was pointed out that the ideal way to minimize energy loss during electronic motion was through the use of thinnest-possible films — in other words, atomically thin films and molecular thin films. Based on the discussion at this workshop, a JST/CRDS Strategic Proposal entitled "Development of New Materials and Innovative Devices Using Atomically Thin 2D Functional Films" was formulated, recommending that the "creation of innovative device core technologies through atomically thin functional films that meet application needs" and the "creation of functional research and scientific principles for device design for atomically thin films with new structures to help radicalize 'seeds' technologies" as specific research and development issues.

Based on these discussions, the "Research and Development Policy for Nanotechnology and Material Science Technologies (Interim Report)" (July 2011) prepared by the Nanotechnology/Material Committee under the Research Program and Evaluation Subcommittee of the Council for Science and Technology established "Reducing energy consumption and achieving multifunctional capabilities for electronics" as a priority research and development issue in order to resolve problems, and indicated that it was important to improve energy-saving performance and accelerate research and development efforts with a view to the global competitive environment. In addition, the interim report entitled "Policy for Promoting Research and Development in the Field of Information Science Technologies" (September 2011) compiled by the Committee on Scientific and Technical Information (CSTI) listed "Ultra-low power consumption (greening) of IT systems" as an approach that would be needed in the future for information science technologies. Subsequently, ongoing discussions have been held by the two committees.

The objectives for this Strategic Object will be prepared based on the results of these studies.

Other:

With countries around the world currently engaged in fierce competition, it is essential for Japan to use its accumulated academic, technical and human resources to maximum advantage, working in cooperation with the Tsukuba Innovation Arena (TIA) and other global centers for concentrated industrial, academic and government collaboration, to build organizations that can link the achievements of basic research in this Strategic Object directly to the strengthening of Japan's industrial competitiveness. To this end, the achievements of efforts at universities, etc. up to now and existing Strategic Basic Research Programs must be actively used, and close cooperation among related projects must be maintained, in order to quickly turn these achievements into practical applications.

5.1.3 Creation of new functional materials by means of technology for controlling spaces and gaps in advanced materials in order to realize selective material storage, transport, chemical separation, and conversion, etc.

Targets to Achieve:

By means of technology for controlling spaces and gaps in advanced materials (technology as a common platform for freely designing, controlling, and utilizing the shape, size, dimension, arrangement and other structural aspects of gaps in inter-element linkages of which substances are formed), this program aims to achieve the following targets toward the creation of novel functions not existing in the original substances naturally and the creation of green/life materials for solving various problems in the environment, energy, medicine, health and other fields, which could not be solved using ordinary materials.

○Creation of innovative spaces-and-gaps-controlled advanced materials enabling selective material storage, transport, chemical separation, and conversion, etc.

○Systematizing the technology for controlling spaces and gaps in advanced materials

Vision for Reaching Achievable Important Goals in the Future:

By achieving the research results stated in the Section "Targets to Achieve" for this Strategic Object, it is possible to create materials with new functions utilizing these various technologies and apply these to the resolution of a broad range of social needs as well as issues in the industrial field. The objective is to, for example, achieve the following results for a period of around five years following the completion of the project with the aim of promoting the green innovation and life innovation prescribed in the 4th Science and Technology Basic Plan (approved by the Cabinet on August 19, 2011) in fields such as environment/energy, medicine/health, and social infrastructure by constructing at an early stage cooperative systems between the academic world and the industrial world—which carries out mass production and commercialization—for each field of application, such as devices and medical products.

- Development of technologies for enabling efficient store and transport of unstable gasses as well as free separation and conversion
- Development of separation membranes that economically and sophisticatedly purify drainage water, contaminated water, and air
- Development of drug delivery systems that provide sensing functions and controlled release functions for active ingredients
- Development of ultra-lightweight and high-strength construction materials through porosity controls that dramatically increase aseismatic/seismic isolation functions

In addition, practical application is also being considered in various other fields, including energy conversion materials such as solar cells and secondary cells, electromagnetic materials such as semiconductors and superconductors, and molecular recognition materials such as sensors and biomaterials.

4. Specific Content

(Background)

Towards a New Concept Based on "Spaces and Gaps"!

In recent years, the degree of freedom in designing substances and materials and controllability of composition and structure have increased dramatically, and the creation of substances and materials that express new functions essential for the realization of a sustainable society is becoming possible. As the result of research conducted over these past 10 years, seed technologies that elicit formation methods for new substances characterized by unique nano-structures as well a ICT Basic Strategy Board of Information and Communications Council, the Ministry of Internal Affairs and Communications, s various functions within porous materials, mesoporous materials, and cage-structured substances, etc., have been uncovered, and amidst fierce international competition, the sharpening of technology is progressing at a remarkable pace. At this point, Japan boasts a high global share in the materials industry and has a high level of basic research, but there is no guarantee that we will be able to maintain our competitiveness in the future. With regard to substances and materials in particular, with rising demand worldwide for the expression of new functions and dramatic improvement on functionality in such fields as high energy conversion, superconductors, high ionic conductors, heat-resistance, high mechanical strength, lightweight materials, bioactivity, medicine, and drug discovery, now is precisely the time that Japan needs to develop strategies ahead of the rest of the world for developing and supplying innovative next-generation materials with new functions under the new concept of "Utilizing Spaces and Gaps", which is a step ahead historically from the concepts of "interfaces" and "surfaces".

(Research Content)

Towards the Creation of New Functions Utilizing "Spaces and Gaps"!

Under the novel concept of creating new functional materials using technology for controlling spaces and gaps in advanced materials, as presented in this Strategic Object, innovations are generated based on multiple technology seeds created in an attempt to achieve objectives and which are shared at a high level of awareness amongst researchers with differing perspectives—basic research, applied research, physics, chemistry, etc.—while the formation of human networks is promoted. Specifically, the objective is the realization of the objective to be achieved and future vision through (1) projects aimed at sharpening the functions based on technological seeds and (2) projects concerning basic technologies aimed towards social implementation—both aimed at the realization of the objective to be achieved, that is, "discovery of new functional materials through the use of control technologies for nano-sized spaces and gaps in materials in order to achieve selective material storage, transport, conversion etc. "—as well as (3) projects concerning observation/analysis technology and elucidation of principles, etc., which are the foundation of materials creation—which is aimed at "systematizing the technology for controlling spaces and gaps in advanced materials"— while promoting mutual cooperation.

- Design and synthesis of spaces-and-gaps controlled materials—"Functional sharpening"
    - Design and functional expression of structure and interaction of spaces-and-gaps controlled materials
    - Develop new synthesis technologies using space-and-gap structures
- Implementation of paces-and-gaps controlled materials—"Social implementation"
    - Expansion of scale from nano to macro; high-strengthening, ultrafast synthesis, reduction of costs
- Construction of common core technologies: "Observation/analysis technology and elucidation of principles"
    - Technologies for observing/analyzing various physical phenomena in spaces-and-gaps controlled materials (substance transportation/storage and substance/energy conversion)
    - Technologies for designing and analyzing space-and-gap synthetic processes as well as structures and functions using computational simulations and multi-scale modeling

Policy Positioning (positioning within the policy system and necessity/urgency in terms of policy etc.)

Under the 4th Science and Technology Basic Plan, for strengthening common infrastructure for the enhancement of industrial competitiveness, "R&D will be promoted into innovative common basic technologies, including basic technologies required for the development and utilization of advanced materials and components of high added-value, large market share or future growth potential. Japan has many technologies of high global competitiveness, and many basic technologies that support the utilization of high-performance electronic devices, information and telecommunications. Therefore, a strategy for appropriately opening up those technologies will be promoted". Furthermore, for the enhancement of cross-sectional science and technology, "The government will promote R&D into nanotechnology and optical / quantum technologies that will lead to the development of advanced techniques for measurement, analysis, etc., advanced information & communication technologies such as simulation and e-science, S&T that is cross-sectionally available in multiple areas such as mathematical science and system science technologies, and S&T for integrated areas". In addition, the "Research and Development Policy for Nanotechnology and Material Science Technologies (Interim Report)" (July 2011; Council for Science and Technology, Subdivision on R&D Planning and Evaluation, Nanotechnology/Materials Science and Technology Committee) states that, "Since the development of innovative technologies is essential for maintaining a competitive edge internationally, rather than focusing solely on unmistakably promising technologies when establishing social projects, research and development efforts aimed at creating technologies with latent potential from a medium-to-long-term perspective should also be promoted", and "spaces-and-gaps control" was specifically mentioned as one "technology for designing or controlling materials", which is a core research and development project aimed at issue-resolution.

As mentioned above, there is also a need for the development of innovative materials in order to achieve three important issues specified in the 4th Science and Technology Basic Plan: "promotion of green innovation", "promotion of life innovation", and "strengthening the industrial competitiveness of Japan".

Coordination with Related Policies, Division of Roles, and Differences in Policy Effects:

Currently, strategic objects related to materials development in Japan include "creation of innovative function of materials by application of nanoscale material structural control technologies, such as controlling the atomic arrangement, towards the practical use of rare-metal-free materials and new targeted functions, such as ultra-high coercivity and ultra-high fracture toughness" (FY 2010 Strategic Object), which aims to clarify the roles of elements that determine the characteristics and functions of substances/materials; and "establishment of molecular technology, which is the free control of molecules to bring innovation to environmental and energy materials, electronic materials, and health and medical materials" (FY 2012 Strategic Object). The thinking behind these existing Strategic Objects is the question of "how can new functions be created by changing material compositions and their components?" In contrast, the Strategic Object here takes the completely opposite approach of asking "how can the spaces and gaps (cages) in between elements and molecules be utilized?" That is to say, there is a complementary relationship between this Strategic Object and existing Strategic Objects in terms of objective and research content and takes a different approach to the common objective of creating new functions. Further solidifying Japan's materials development base through the synergetic effect between this Strategic Object and existing Strategic Objects will make it possible to bring about innovations in the development of new materials in a range of fields, including environment/energy and medicine/health. Furthermore, one example of spaces-and-gaps controlled materials is catalysts and energy carriers (carriers for transporting/storing energy), but coordination is required such as sharing of the research results and core technologies with "creation of leading substance conversion technologies through catalysts aimed at responding to issues such as environment/energy and drug discovery" (FY 2012 Strategic Object) and "creation of core technologies using innovative energy carriers aimed at transporting/storing/utilizing renewable energy" (FY 2012 Strategic Object).

The Ministry of Education, Culture, Sports, Science and Technology is promoting environmental improvement to enable sharing of research facilities/equipment and fusion of different fields through the implementation, beginning in FY2012, of "Nanotechnology Platform" projects to construct a national system for sharing nanotechnology-related research facilities. Under this Strategic Object, active utilization of "forums" for industry-academia-government collaboration and facilities/equipment owned by universities/independent administrative institutions and opened widely to users is required from the perspective of effectively promoting research, efficiently utilizing existing facilities/equipment, and eliminating duplication of facility/equipment installation.

Scientific Justification for the Research and Development Goals (need, urgency, achievability etc. based on domestic and international research trends):

The main groups of spaces-and-gaps controlled materials are zeolite, mesoporous materials, porous metal complexes (metal organic frameworks (MOF))/porous coordination polymers (PCP). In particular, in recent years there has been a worldwide increase in the number of papers published on MOF/PCP, especially in China, and in “Materials Science and Technology 2011” (published by Thomson Reuters), MOF was listed as one of the three research themes currently gaining attention. China’s response to this field is described as follows: “These data demonstrate that research on MOFs is a priority realm of research for Chinese researchers and for the Chinese government, presumably not merely for academic interest but also for the enormous potential of MOFs for energy storage and other industrial applications.” Furthermore, according to Thomson Reuters’ analysis based on the citation count for papers, “mesoporous silica nanoparticles for drug delivery and biosensing applications” and “highly ordered mesoporous polymer and carbon frameworks” are also currently gaining attention on a global scale.

In Japan, in addition to successfully achieving the synthesis of mesoporous silica for the first time in the world, the potential for application of porous coordination polymers (PCP) has been gaining attention since the 1990s and world-class research results have been achieved; thus Japan has led other countries in experimenting with the use of “spaces and gaps”. Recently the realization of a highly active ammonia synthesis catalyst utilizing $12CaO \cdot 7Al_2O_3$ (a chemical compound comprising C12A7, calcium oxide, and aluminum oxide)—the structure of which is linked in a nano-sized cage-like skeleton, which is also a component of cement—was announced. This has been gaining attention in both the industrial and academic worlds as a discovery bringing about innovation in the ammonia production technology established approximately 100 years ago (Haber-Bosch process). Furthermore, since the Great East Japan Earthquake, zeolite and other nanoporous materials have been gaining attention for their applicability in the recovery and removal of radioactive elements such as cesium. Thus, expectations are held for new advances to be made in the resolution of various issues using spaces-and-gaps controlled materials.

Based on the above-mentioned domestic and international research trends, Japan should also fully utilize its rich academic and technological experience and accumulation of human resources to urgently implement basic research focused on the development of applications under the new concept of “spaces and gaps”.

Background to Deliberations:

At the “Workshop on Long-term Impacts and Future Opportunities for Substances/Materials” (December 2008) and “Workshop on Long-term Impacts and Future Opportunities for Nanotechnology” (August 2009), held by the Japan Science and Technology Agency Center for Research and Development Strategy(JST/CRDS), the importance of developing materials with new functions using nanotechnology was reconfirmed and “technology for controlling and utilizing spaces and gaps” was identified as a key issue, and the “Workshop on Science and Technology Strategies for the Future: ‘Technology for Controlling and Utilizing Spaces and Gaps’” (October 2009) was consequently held. Here, in addition to achieving shared awareness that “methodology for designing and controlling spaces and gaps is an important, core concept as a guiding principle for initiating the development of new substances, and that specific technologies for achieving this contribute greatly to resolving social issues and strengthening industrial competitiveness”, specific technology issues were identified and consideration given to issues related to system design. Based on these discussions, the CRDS strategic proposal “Technologies for Designing and Utilizing Spaces-and-Gaps Controlled Materials: Contributing to a Sustainable Society through Fusion of Different Fields” was formulated, and it is expected that “methodology for creating innovative substance functions through the design and control of minute spaces and gaps” will be shown to be a core concept that will contribute greatly to the resolution of global-scale social issues and strengthening of Japan’s industrial competitiveness.

Based on the above discussion, the “Research and Development Policy for Nanotechnology and Material

Science Technologies (Interim Report)" (July 2011; Council for Science and Technology Subdivision on R&D Planning and Evaluation, Nanotechnology/Materials Science and Technology Committee) clarified the positioning of "control of spaces and gaps (realization of high specific strength, toughness, selective permeability, and reactivity in nano, micro, and milli multi-scale porous structures)" as an important research and development topic for resolving issues and as "technology for designing and controlling substances and materials" in the "science and technology infrastructure" topic field. The summary pointed out the need for a new framework to integrate activities across existing organizations, and since then regular discussion of this topic have continued.

Furthermore, the Council for Science and Technology Policy Expert Panel on Promotion of Policies for Science and Technology Innovation Working Group for Considering Common Core Technologies for Nanotechnology and Materials identified the area of spaces-and-gaps controlled materials as a technology field that requires strengthening in the future (November 2012), and indicated the importance of not only establishing patent portfolio and making concentrated efforts towards practical application of these technologies but also of concurrently taking basic approaches, including computational science, aimed at understanding mechanisms such as synthesis, physical properties, and interaction.

This Strategic Object was formulated based on the results of these deliberations.

Other:

For this Strategic Object, basic research focused on application development is being promoted under the new concept of "spaces and gaps". In order to resolve various issues in fields such as environment/energy and medicine/health, an environment for actively involving researchers in various research fields centered on technology for controlling space-and-gap structure and facilitating practical cooperation amongst them. Moreover, in order to further develop the results of this Strategic Object with the aim of constructing common core technologies, efforts need to be made to create a cooperative system between the academic and industrial worlds at an early stage.

5.1.4 "Creation of theory, mathematical model, and fundamental technology to establish a cooperative distributed energy management system, which enables the optimization of demand and supply for various energies including renewable energy"

Targets to Achieve:

The following three goals are to be achieved in order to create the theory, mathematical model, and fundamental technology to establish infrastructures that enable the introduction of renewable energy stably and on a large scale, optimize various energy resources, and are tough in case of disasters.

- Creation of theory and fundamental technology to grasp the status of, estimate, and forecast demand and supply of renewable energy
- Creation of theory and fundamental control technology for establishing a cooperative distributed energy management system that controls various energy demand and supply

Creation of theory and fundamental technology to clarify integrated mechanism of energy network of demand side and supply side, optimize energy management considering human behavior, and pursue social rationality of the whole system.

Vision for Reaching Achievable Important Goals in Future:

This Strategic Object is aiming to develop theories and fundamental technologies involved with the establishment of a cooperative distributed energy management system. Specifically, it aims to realize an energy supply-demand system with excellent economic efficiency and stability during disasters by operating technologies involved with the supply and demand of diversified energies (including solar panels and storage batteries), such as renewable energies by combining them based on regional characteristics and uses, identifying and analyzing real-time supply-demand balance in both ways, and optimizing the energy system of dispersed energy system and conventional power system based on supply-demand forecasting and consumption forecasting information.

Another goal is to lead research and development outcomes gained from objective basic research to efforts toward actual application in society. In this process, the coordination with empirical projects for the use of smart systems and greening of urban energy infrastructures supported by the national and municipal governments should be carefully examined. This strategy thereby aims to establish a cooperative distributed energy management system. This strategy also aims to promote the spread of such a system in society, increase the capacity of renewable energies where the rate of power generation is unstable, and realize robust energy infrastructures that withstand disasters. In addition, this strategy aims to contribute to the achievement of *"Realization of a stable energy supply and low-carbon energy source usage"*, which is an important task for achieving the objective of green innovation as listed in the 4th Science and Technology Basic Plan. This strategy also aims to contribute to the realization of a more sophisticated smart community by applying theories and simulation technologies built under this Strategic Object to proposals for energy policies.

Furthermore, this strategy aims to contribute to the strengthening of Japan's ability to build social and technical systems by thinking about implementing overseas projects as social infrastructure packages and leading the effort to establish international standards for fundamental technologies in the building new, dispersed, and cooperative energy management systems. It also aims to reduce CO_2 emissions and mitigate global climate change by transferring the technologies to many countries and regions in the world.

Specific Content:

The following points must be scientifically examined when discussing energy strategies as to what types of new energy systems should be established as social infrastructures of Japan in the future; coordination between dispersed energy systems including renewable energies and conventional power systems; maximum use of a variety of energy sources including thermal energy; stability of energy system including in cases of disasters; cost of building the systems in the society.

These scientific examinations require the participation of researchers from the field of power transmission and distribution engineering, the field of power electronics, and the field of power measurement, all of which have been the main participants in the establishment of energy systems in Japan. In addition to these fields, participation by researchers in a variety of fields, including systematic science, is needed to establish a new energy management system. For example, research and development needs to be implemented by integrating researchers from a variety of fields as follows; control technologies, optimization technologies, and mathematical model and simulation technologies to establish and operate a diversified and complicated system; sensor network technologies and data mining technologies for high-speed processing and analysis of obtained data; network theories for analyzing structures and features of complicated systems; global environmental measurement and forecasting technologies to forecast natural energies; forecasting of energy consumption which takes into account of human behavior.

Through interdisciplinary research and development like these, studies on theories and development of fundamental technologies applicable to complicated, dispersed systems will be implemented to contribute to the establishment of a cooperative distributed energy management system for maximum use of a variety of energies including renewable energies.

In addition to contributions to Japan's energy policies, these efforts are expected to produce new scientific principles and academic fields through the integration of multiple fields, such as the field of information communication and the field of measurement control (integration of the real world and the information society). Universal and fundamental theories and technologies that can respond to various needs are also to be established because the requirements for energy systems dynamically change depending on regions and social situations of a given time. There are possible approaches to realize this goal as follows; an approach based on actual data based on the current energy systems; implementation of system control theories and technologies that have already worked in other fields such as automobile and robot engineering; an approach of exploring an ideal system from scratch without using the preconditions of restrictions applied to the current energy systems.

Examples of detailed approaches are described below.

[Approach 1] Studies on theories and fundamental technologies for stabilization and optimization of a cooperative distributed energy management system

They conduct studies on information communication technologies for mutual and real-time interactions of both energies and information among demand-side and supply-side subsystems that are dispersed (large-scale photovoltaic power stations (mega-solar) and groups of wind turbines for power generation (wind farms), large storage battery systems, factories with co-generation systems, groups of buildings and residential areas equipped with solar panels, etc.). Also, they conduct studies on information processing technologies that analyze conditions in which energy suppliers and consumers mutually check and coordinate their statuses based on a large volume of sensor information. They conduct studies on algorithms and mathematical models for optimizing the entire dispersed energy systems based on analytical data. They conduct studies on power electronics needed to stabilize energy systems. They conduct studies and developments to find optimal systems by running quantitative analyses and evaluations on the following evaluation indexes: quality of electricity (voltage, frequency); cost; operation efficiencies of power generation facilities and transmission and distribution facilities; amount of CO_2 emissions; amount of power generation; system stability; and tolerance against disturbances such as malfunctions and natural disasters.

- Studies on advanced simulation that forecasts the amount of renewable power generation
- Studies on cooperative distributed control system with forecasting theories and estimating theories
- Studies on topology control of electric power network that prevents the spread of blackouts and enables self-recovery
- Studies on applying optimization methods to the cooperative distributed energy management system
- Studies on optimization control theories for the control of supply-demand balance that takes into account of the energy transfer between photovoltaic power generation and electric vehicles
- Information communication technologies for mutual and real-time interactions of energy and information between consumers and suppliers
- Studies on information processing technologies for high-speed acquisition and analyses of data needed for system control from a large volume of sensor data and studies on elemental technologies such as power electronics which are main parts of system control

[Approach 2] Establishment of energy consumption models that take into account human behaviors and design of optimization mechanisms of energy supply-demand balance based on the model

They conduct studies on the establishment of energy consumption models that take into account human behaviors and optimization mechanisms of the energy supply-demand balance based on models in order to lead the selfish decision making of consumers and suppliers to social benefits of the entire energy system. For example, quantitatively demonstrate what kind of changes to electricity prices through renewable power generation and conventional large-scale power generation would make the following conditions attainable; to perform peak-cut and peak-shift of power demand while balancing demand and supply; to warrant social benefits such as CO_2 reduction and economic reasonability.

- Studies on optimization methods of the overall dispersed energy system by demand control through the use of intelligent next-generation systems capable of information gathering and control
- Studies on dynamic electricity price decision mechanisms for stable and optimal decisions of the distribution of energy consumption and supply based on theories such as mechanism design theories and game theories
- Studies on the design of energy consumption model based on behavioral economy and studies on methodology for social consensus building on energy systems

[Approach 3] Studies that enable highly accurate demand forecasting and renewable energy generation forecasting using methods, such as ones that improve forecasting performances by learning from satellite data, regional meteorological observations, geographical information, and past supply-demand records

- Establishment of models concerning physical quantities related to the generation of renewable energies (data such as the amount of solar radiation, wind velocity and direction, and ground surface temperature which are calculated by combining data from earth observation satellites, meteorological observation data, and global environmental models) and studies on semi real-time forecasting systems based on the models
- Studies that enable forecasting of the amount of renewable energy generation in individual regions through integrated analyses of regional environmental parameter forecasting and regional geographical information (terrains, information of locations such as the locations of renewable energy power plants, population and industrial distribution, etc.)
- Studies on land use models that take into account of the variation of natural energies based on time and space (e.g. location models of renewable energy generators)
- Studies on electricity demand forecasting using application and learning technologies that improve forecasting performance by learning from past supply-demand records and multi-agent simulation

[Approach 4] Development of computer simulations and simulators, and studies on comprehensive analyses and evaluation of theories and system technologies using the simulators

- Creation of hybrid simulator technologies by integrating small-scale experimental devices and using actual data
- Creation of fundamental technologies which contribute to the development of high-precision simulator of energy supply-demand network control using parallel distributed computers
- Comprehensive analyses and evaluation studies of approaches 1 through 3 using computer simulations and simulators

Policy Positioning (positioning within the policy system and necessity/urgency in terms of policy etc.):

The 4th Science and Technology Basic Plan (Cabinet Decision on August 19, 2011) states the following goal toward the realization of green innovation, one of the growing fields in the New Growth Strategy (Cabinet Decision on June 18, 2010). The Basic Plan states that it is necessary to quickly implement the development and spread of innovative renewable energies, the establishment of dispersed energy systems, and the construction of robust social infrastructures for the stable supply and acquisition of energy. Based on this statement, the Basic Plan aims to promote research and development of energy management, such as smart grids that perform comprehensive and optimal control of supply systems of both key energies and dispersed energies, and energy demand systems and to spread these technologies overseas. This Strategic Object aims to resolve various problems at the basic research phase, which is needed to achieve this goal.

This Strategic Object also expects cross-cutting research combining forecasting technologies using satellite data and fundamental control technologies including system science such as control, signal processing, modeling, simulation, network, and adaptive learning. The cross-boundary implementation contributes to *the promotion of research and development in science and technologies that are applicable to multiple fields such as nano-technologies and photon quantum science that result in the development of cutting-edge measurements and analytical technologies, advanced information communication technologies such as simulations and e-science, mathematical science, and system scientific technologies* as stated in the 4th Science and Technology Basic Plan.

The full-scale introduction of renewable energies to the system has become an urgent policy issue due to the changes in situations after the Great East Japan Earthquake. The Energy and Environmental Meeting of the Realizing the New Growth Strategy meeting started discussions on creating new dispersed-style systems in addition to the improvement of conventional, centralized systems. The *realization of a dispersed energy system* is included in one of the Basic Principle 2: Three principles toward the realization of a new energy system in the interim arrangement of the meeting, meaning that it is positioned as an issue of high necessity.

Coordination with related policies, Division of Roles, and Differences in Policy Effects:

Relevant policies of this Strategic Object are as follows: the Japan-US Smart Grid Experiment (fiscal year 2009–2013) that New Energy and Industrial Technology Development Organization (NEDO) is conducting in New Mexico, the United States; the empirical project for the next-generation power distribution and transmission system optimization and control technology, the empirical project for the next-generation mutual communication output and control, the empirical project for the development of photovoltaic power generation and output forecasting technology, and the empirical project for the next-generation energy and social systems that the Agency for Natural Resources and Energy is implementing. These projects are installing various smart grid technologies in actual systems and running experiments in specific areas. Technologies that enable optimal control of a power system when renewable energies are introduced to a stable, integrated power network are being developed in empirical projects for the next-generation power transmission and distribution system optimization and control technologies.

Meanwhile, this Strategic Object has an image of the goal of achieving a cooperative distributed energy management system and aims to establish universal and fundamental theories, mathematical models, and fundamental technologies to realize the images. Thus, this Strategic Object gathers researchers from a variety of research fields, such as energy including electricity, power electronics, measurement and control, statistical mathematics, information communication, information processing, meteorological forecasting, and social science and promote research and development. It also aims to produce new theories and academic fields by combining different fields in addition to making contributions to Japan’s energy policies.

Achieving this Strategic Object enables productions of basic models for systems that can flexibly work with various energy sources (photovoltaic power generation, wind power generation, cogeneration, and storage of electricity, etc.) and restrictions based on scales of control systems (within households, factories, small communities, etc.) and regional differences (weather conditions, geographical conditions, etc.) in addition to evaluations that combine various perspectives (costs, energy efficiency, amount of $CO2$ reduction, etc.). Therefore, research outcomes of this Strategic Object are expected to be used in optimal control of energy systems in empirical projects and to enable the design of energy management systems that can be applied to a variety of communities in the future. These are roles of this Strategic Object that are not seen in other projects. Besides the introduction of a large volume of renewable energies, this Strategic Object aims to establish theories needed to build dispersed energy management system that withstands disasters. In addition, operating energy management systems in rapidly growing Asian countries as social infrastructure packages brings national benefits to Japan and contributes to the mitigation of global environmental problems. When planning to operate the system overseas like this, research organizations such as universities are expected to take the initiative and build neutral fundamental technologies for system controls based on scientific methods as the initial phase. Based on these fundamental technologies, companies will package them as internationally competitive products and proceed to overseas operation and international standardization of the research outcomes.

Scientific Justification for the Research and Development Goals (need, urgency, achievability etc. based on domestic and international research trends):

The number of presentations at conferences, published papers, special magazine editions, and special sessions at conferences on smart grid has been increasing over the past few years. This trend is represented by the fact that the research field of smart grid was added to *IEEE Transaction*, the journal published by the Institute of Electrical and Electronics Engineers as *IEEE Transactions on Smart Grid* in 2010. Leading researchers from the field of system science technology has joined this field for rigorously conducting research on developing theories and fundamental technologies for stability and optimization of dispersed energy systems using cutting-edge mathematical and statistical models and algorithms.

Real-time pricing in which electricity prices are dynamically and flexibly changed can be expressed as a strategic mutual relationship between the consumer, which is a social system, and the supplier which is a technical system. Thus, various researchers are studying real-time pricing as themes of a boundary field of control engineering, applied mathematics, economics, and electrical engineering. Among these fields, active discussions on approaches based on game theories and team theories have started.

Japan has been taking a leading position in the world in terms of individual elemental technologies such as the field of power electronics. A future problem will be how the overall elemental technologies for smart grids should be constructed as a system. Strategically promoting research in system science technologies by linking them with the outcomes of abundant elemental technologies could enable Japan to establish a research structure and implementation structure that lead the rest of the world.

In the United States, the Department of Energy is working on a smart grid with the National Oceanic and Atmospheric Administration (NOAA) of the Department of Commerce, which is in charge of meteorological and weather forecasting. Multinational companies are also thinking about using meteorological forecasting information for power generation in the Middle East and seeking Japanese universities that are studying meteorological and weather forecasting to transfer technologies to them. It is necessary to introduce these technologies to other countries while protecting the outcomes of research and development conducted in Japan as national benefits; promotion of research and development is an important issue.

Quick establishment, practical application and horizontal implementation, including technical transfer overseas of energy infrastructure technologies for the introduction of a large volume of renewable energies is the role of Japan when it comes to the mitigation of global environmental problems, which are the issue shared by all of us. The establishment of methodology of system constructions that put economic efficiency and expansibility in perspective is urgently needed for this role.

Background to Deliberations:

The Center for Research and Development Strategy (CRDS) of the Japan Science and Technology Agency held four conferences with scholars and discussed important topics that can be solved as system science technologies. Based these discussions, CRDS compiled the strategic proposal, "Toward the resolution of important issues of system construction ~Strategic proposal on the implementation policy of system science technologies~" in March 2011. In August 2011, CRDS also hosted a workshop, "Renewable energy and dispersed control system" in which scholars discussed and examined technical issues associated with dispersed control system.

This Strategic Object was produced based on the outcomes of these discussions and examinations.

Other:

It is important to pay attention to the direction of energy policies in Japan and the world in order to build fundamental basic technologies that realize effective and efficient energy infrastructures. Proper coordination with projects implemented by other government agencies is also desirable to establish the relationship for transferring outcomes and receiving supports for empirical projects.

5.1.5 Establishment of molecular technology, which is the free control of molecules to bring innovation to environmental and energy materials, electronic materials, and health and medical materials

Targets to Achieve:

Establishment of molecular technology is to be achieved, which is a series of techniques to exploit fully features of molecules to create the desired functions by designing, synthesizing, operating, controlling, and integrating molecules on the basis of scientific findings in fields of physics, chemistry, biology, mathematics, etc. For this, the following technology systems are established, which are basic technologies to realize super-low-power consuming and ultra-light devices utilizing molecules for battery device, organic thin-film solar cells, and etc. and to establish innovative methods of treatment such as drug delivery systems, functional medical materials, etc.

- Establishment of technology systems of *molecular technology for designing and creating molecules*, which freely design and create new functional materials in cooperation with precision synthesizing technology and the theory-computational science.
- Establishment of technology systems of *molecular technology for shapes and structure control*, which leads to creation of new functions through accurately control molecular shape and structure.

Vision Reaching Achievable Important Goals in Future:

As represented by organic EL displays, various parts and devices are already shifting to soft materials, which are molecular materials. This trend implicates that soft materials gives fundamental solutions to issues that the entire human society faces, such as the reduction of environmental burdens, responses to restricted resources, and high biocompatibility; in other words, molecular technologies that realize soft materials give solutions to such problems.

Under this Strategic Object, obtaining research outcomes described in section "Targets to Achieve" enables the designs of functions as molecular materials, which consequently enables the application of the outcomes to solving a variety of problems associated with social needs. Green innovation and life innovation described in the 4th Science and Technology Basic Plan are to be promoted by building a cooperative structure between research of relevant academic fields and industries. For example, efforts will be made to achieve the following outcomes within about five years after the completion of projects.

- **Electronic devices build with soft materials**

  Organic materials with conductivity control capability are used as components of electronic devices in place of the conventional semiconductors and metals, and computers with low environmental burden and ultra-low energy consumption and ultra-light portable information terminals are created.
- **Resource-recycling solar cell films with ultra-low energy consumption**

  Solar cells that are ultra low cost and produce low environmental burdens are created with components that use molecular materials and conversion of manufacturing processes.
- **Medical treatments using drug delivery system, etc.**

  Safe and effective medical treatments are realized through the development of sophisticated drug delivery system equipped with detection functions and functions to regulate the discharge of active ingredients and three-dimensional structuring of functional medical materials needed for regeneration of tissues and organs.

Besides these aspects, practical applications in fields such as reduced use of fossil resources, high-density secondary cells, advanced environmental monitoring, low-cost water production, and purification are possible.

Specific Content:

(Background) From molecular science to molecular *technology*!

In the recent years, for instance, the use of thin membrane, n-type semiconductor made with molecular called fullerene is resulting in rapid progress in the development of organic solar cells that are receiving attention as power generation technologies with low environmental burdens. Meanwhile, in the field of pharmaceutical development, designing molecular structures and shapes with computers has drastically reduced side effects and enabled the production of molecularly targeted agents that specifically work on lesions.

Basic science called molecular science exists in the background of such achievements. Conventional molecular science has discovered and analyzed various molecules by observing and exploring in nature and obtained similar functions as natural molecules by artificially mimicking their features. With the rapid progress in computer performances and drastic progress of measurement and analytical technologies in the recent trends, however, research and development that design intended functions and obtain suitable materials without seeking models in nature have emerged.

Given these circumstances, this Strategic Object aims to deliver a radical breakthrough to the series of material development technologies that support environmental and energy technologies, information communication technologies, and medical material technologies by developing molecular technology.

(Contents of study) For the establishment of basic technologies shared by life innovation and green innovation!

In order to produce innovative outcomes involved with green innovation and life innovation, this Strategic Object aims to accelerate research and development of individual policies and fusion of different fields by building a solid foundation of molecular technologies that can be applied to a various fields <u>separately from</u> research and development in individual tasks of application. Research and development of molecular technologies cannot be easily implemented only by using the knowledge of independent academic fields, such as conventional chemistry, physics, biology, and mathematics. Thus, it is important to recognize the bottleneck in the tasks of application as a common problem and establish a system that overcomes this problem through the approach which integrates different fields. This Strategic Object perceives molecular technologies as the technology consisting of the following six elemental technologies. 1) Molecular technology for design and creation, 2) molecular technology for controlling shapes and structures and 3) molecular technology for conversion and processes, which are trans-boundary technologies. Then, 4) molecular technology for controlling electronic state, 5) molecular technology for controlling aggregations and compounds and 6) molecular technology for controlling transportation and transfer, which are intended for the use in a specific field of application. This Strategic Object specifically puts emphasis on *molecular technology for design and creation* and *molecular technology for controlling shapes and structures*, which are the most basic of all these technologies. Examples of specific topics of research and development are described below.

- **Molecular technology for design and creation**

  Molecular technology for design and creation is the technology that aims to freely design and create new functional materials. In other words, in addition to the conventional method that largely depends on instincts and experiences, this technology gives governing principles to freely design and synthesize materials which have the target functions through tight cooperation between syntheses and theoretical analyses.

  (Examples of topics of research and development)

- Production of theories for creating molecules from functions and development of simulation technologies
- Cultivation of molecular design methods which enables forecasting of molecular structures
- Development of methods for precision syntheses based on functional designs and forecasting
- Development of high-purity purification method of molecular substances

- **Molecular technology for controlling shapes and structures**

  Molecular technology for controlling shapes and structures freely creates one-dimensional, two-dimensional, and three-dimensional macro structures for building practical materials based on molecular-level nano structures produced from molecular sequences, molecular assemblies, and self-organization. This technology also leads to the production of new functions by tightly controlling molecular shapes and structures.

  (Examples of topics of research and development)

- Technologies to create spatial and pore structures through build-up and top-down methods including self-organization
- Technologies to expand sizes from nano to macro structures
- Observation and analytical technologies of physical phenomena in materials consisting of macro structures
- Designs and analyses of macro-level structures and functions using computer simulations

Policy Positioning (positioning within the policy system and necessity/urgency in terms of policy etc.):

Soft materials produced by molecular technologies have various capabilities that satisfy various tasks of the 21^{st} century, such as low environmental burden, energy and resource efficiency, low cost, and compatibility with the people and the society. The greatest goal of this Strategic Object is to solidify the position of molecular technologies that realize these aspects as the basic technology of Japan. Industries with added values that molecular technologies produce will support the economic growth of Japan and make great contributions to solving problems such as global environmental and energy issues, safety and security issues, and medical and health issues.

The 4th Science and Technology Basic Plan (Cabinet decision on August 19, 2011) states, "Research and development concerning innovative common basic technologies with high rate of added values and market share, high possibility of future growth, and international competitiveness that favors Japan such as basic technologies needed for the development and use of cutting edge materials and basic technologies that support the use and utilization of advanced electronic devices and information and communication shall be promoted while promoting proper strategies to make these technologies open to others" in order to solidify common grounds for the reinforcement of industrial competitiveness. It also states, "Research and development shall be promoted on scientific technologies that can be horizontally used in multiple fields and science and technology of integrated fields such as nano-technology and photo quantum science which lead to development of advanced measurement and analysis technologies, advanced information communication technologies such as simulation and e-science, mathematical science, and system science technology" in order to strengthen cross-boundary scientific technologies. In addition, "Policies on research and development of nano-technology and material science technologies <interim summary>" (July 2011, Nano-Technology and Material Science and Technology Committee, the Subcommittee of Research Plan and Evaluation, the Council for Science and Technology) stipulates, "Development of innovative technologies is essential for remaining internationally competitive; thus, efforts such as research and development toward the production of potential possibilities should also be promoted based on the mid- to long-term perspectives rather than emphasizing on technologies which are available when setting up social issues." Molecular technology is listed as one of "technologies for designing and controlling substances and materials," which is a focused research and development task for solving problems.

Coordination with related policies, Division of Roles, and Differences in Policy Effects:

Policies that try to solve problems in individual application themes, such as solar battery, storage battery, and pharmaceutical development have been the mainstream. This Strategic Object, however, is intended to reevaluate technical problems that have become bottlenecks in various fields using a cross-boundary technical concept called "molecular technology" and to promote joint studies by researchers from different fields. Molecular technology constructively reorganizes the achievements of basic sciences that Japan has been accumulated over many years and constructs an unprecedented and new technical structure. Contributions from basic sciences, such as physics, chemistry, biology, and mathematics as well as engineering fields such as nano-technology, information technology, and bio-technology are essential in the process of implementing and structuring molecular technology. These academic fields need to be integrated, and various technologies must be utilized as an integrated unit; therefore, these fields must be integrated at technological levels such as material design technologies and process technologies.

The Strategic Object to be established in fiscal year 2012, "Advanced Catalytic Transformaiton program for Carbon utilization" plans to start a development of new catalyst for material conversion. This technology can supplement molecular technology for conversion and processes, which is an important elemental technology for establishing molecular technology and thus is expected to arrange necessary coordination.

Scientific Justification for the Research and Development Goals (need, urgency, achievability etc. based on domestic and international research trends):

This Strategic Object is a new material technology strategy for Japan to take initiatives in contributing to solving problems such as environmental and energy problems and problems on medicine and health. Japan has strong material industries grounded on nano-technology and material science and is especially competitive in molecular technology as a part of this Strategic Object. For example, Japan's market share for many molecular materials used in display products is overwhelmingly high in the global market. Neither Japan nor other countries has implemented strategic and comprehensive investment in research to academically explore fundamental aspects of this new technological field and improve its innovativeness. There is a possibility that Japan can lead the world if we worked on this field ahead of other countries.

Background to Deliberations:

The Center for Research and Development Strategy (CRDS) of Japan Science and Technology Agency held the Substance and Material Field Overview Workshop in July 2008 in which participants discussed outcomes of nano-technology, effects of integration, and future issues and proposed the establishment of the concept of molecular technology. The Science and Technology Future Strategy Workshop "Molecular Technology" was held in December 2009. This workshop aimed to discuss whether molecular technology could become an important key technology through intensive discussions of specialists and find future directions and specific research and development topics. Based on discussions in the workshop, participants further examined research domains and themes to be intensively promoted in the future and summarized the strategic initiative, "Molecular technology, production of new functions from the molecular level - Contribution to sustainable societies with the integration of different fields" in March 2010.

Based on above discussions, Nano-Technology and Material Science and Technology Committee, the Subcommittee of Research Plan and Evaluation, the Council for Science and Technology of Ministry of Education, Culture, Sports, Science and Technology listed molecular technology as one of "technologies for designing and controlling substances and materials," a focused research and development task for solving problems, in "Policies on research and development of nano-technology and material science technologies" prepared as an interim summary in July 2011.

This Strategic Object was prepared based on the outcomes of these examinations.

Other:

The development of molecular technology requires the environment for researchers from different fields to actively participate and effectively work together. It is also important to perceive molecular technology as a common basic technology in precompetitive domains for expanding the outcomes of this Strategic Object toward the establishment of molecular technology and to actively use places such as Tsukuba Innovation Arena for the cooperation among the industry, the academia, and the government.

5.1.6 To realize breakthroughs in phase-interface phenomena and create basic technologies for high-functionality interface that will result in dramatic advancements in highly-efficient energy utilization

Targets to Achieve:

○ Breakthroughs in energy transport and conversion mechanisms through phase interfaces that provide highly-efficient energy utilization
○ Creation of modeling and simulation technologies that support integrated analysis and design related to phase-interface phenomena at various nano-, meso-, and macroscales
○ Creation of basic technologies such as mathematical scientific methods for controlling and optimizing phase-interface structures
○ Creation of high-functionality interfaces to realize the theoretically possible maximum performance of

equipment and devices

Vision for Reaching Achievable Important Goals in Future:

To achieve maximum reduction in energy loss that inevitably occurs in various energy devices, research that goes back to the basics of phase-interface science is required, and this necessity is indicated in research and development projects at the application level. There are many types of phase interfaces, and they can be broadly categorized according to function as follows:

- Thermohydrodynamic interfaces: Hydrodynamic interfaces, heat transfer interfaces, and separation/adsorption interfaces, etc.
- Chemical interfaces: Chemical reaction interfaces, electrochemical interfaces, and photochemical interfaces.
- Solid state physics interfaces: Thermoelectric interfaces, photoelectric interfaces, and electronic device interfaces.

Breakthroughs in these interface phenomena are an important key to the solution of issues that emerge in both new and existing basic technologies. These technologies are the objective of research and development in the field of environment and energy, which will be described below.

By the attainment of these Strategic Objects, we aim to enable the drastic reduction of energy loss at phase interfaces by deepening the basic scientific principle and the control/optimization technology of phase interface. In addition, we aim to find clues that will lead to the discovery and creation of new phase-interface functions and formation mechanisms.

By means of modeling and simulating for integrated analysis and design of phenomena at various nano-, meso-, and macroscales and by developing mathematical science methodologies for the concrete control and optimization of phase-interface mechanisms, we aim to effectively apply the results of advanced basic research to the design of actual devices and systems.

In such a manner, with a view to creating innovations in the basic phenomena pertaining to energy transport and conversion, we aim to adopt an integrated approach that transcends the boundaries of existing specialized fields and/or integrates scientific knowledge from diverse fields for drastically improving the performance of devices as well as reducing carbon footprints and costs. Further, by carving out the path for achieving broad and rapid deployment of these advances in the society and industry, we aim to make far-reaching contributions to critical issues “conversion to high-efficiency and smart energy usage” related to the realization of Green Innovation.

It should be noted that these Strategic Objects are not merely concerned with energy transport and conversion, but they drive the creation and enhancement of phase-interface science related to production and consumption activities of our society, contribute to the excellence of a variety of technologies, and bear fruit in mid- and long-term social and economic results.

The technological fields for which we aim to develop research results are listed below. It is also expected that beyond contributions to the following technological fields, these results will also contribute to problem solutions that will produce drastic improvements in energy usage efficiencies.

○ Drastic improvements in the heat engine efficiency by means of a complex thermal hydraulic control

In various engines and thermal power plants, most of the irreversible energy loss that assumes the largest role in energy conversion occurs because of temperature differences associated with heat transfer as well as compression/expansion progression flow losses.

A system’s heat conversion loss and flow loss can be greatly reduced, its performance limit achievement level can be increased, and major cost reductions can be realized by means of surface texture control of hot matter transport elementary processes, such as erratic gas or fluid flow (turbulence) or gas/fluid/solid phase interface (such as boiling) from the micro- to macrolevels, as well as surface texture control of the contact condition (wettability) between solid surfaces and fluids.

○ Conservation of energy and reduction of carbon emissions by reducing friction resistance in transport equipment

The transportation sector, which is responsible for realizing major reductions in carbon emissions, includes not only the automobile industry but also maritime trade and is responsible for a considerable percentage of Japan's total emissions.

By controlling turbulence and complex flux on gas/fluid/solid interfaces—for example, two-phase flow that occurs when flows with two different phases, such as gas and fluid, are combined—it is possible to achieve significant reductions in resistance in automobiles, ships, and even in airplanes, thus reducing carbon emissions and contributing to improved product competitiveness.

○ Breakthroughs in electrode interface reaction mechanisms, such as fuel cells and rechargeable batteries, as well as optimization of phase-interface configurations

In microporous electrodes, such as fuel cells and rechargeable batteries, performance is determined by reactions pertaining to gas, ion, electronic diffusion, and electrochemical interfaces (solid/solid/gas). By innovations based on high-level simulations and advanced measurement technology, breakthroughs can be achieved in elementary processes related to these electrochemical interfaces. These breakthroughs, such as optimization of multiple porous electrode interfaces, dramatically contribute to performance improvements and cost reduction.

○ Heat pump innovations achieved by upgrading heat transfer, mass exchange, and phase separation technologies

Challenges for air conditioners and heat pumps include improvements in efficiency, downsizing, and reductions in the amount of the refrigerant.

Optimized design and new production technologies will be developed based on elementary process breakthroughs in innovative heat transfer, mass exchange, and phase separation interfaces. Contributions to problem resolution will be achieved by performing basic research.

○ Detailed analysis of membrane structure separation and performance upgrading of pore diameter and phase-interface configurations

To optimize the design of fluid and solid-phase-interface functions and configurations for various types of separation membranes, precision analysis of membrane structure and the development of technologies to control surface texture and pore size will enable us to contribute to dramatic performance improvements and cost reductions.

○ Higher efficiency achieved by interface control for power semiconductor devices

Most semiconductor devices are structured as multiple layers of superimposed membranes made of diverse materials. The interfaces that exist between different materials are important factors governing the properties of the membranes.

To achieve higher efficiency of semiconductor devices, an understanding of the basic interface physics of a structure that is “embedded” and not exposed to the surface is required.

By means of systematic basic research on heterogeneous solid interface formation processes, carrier transport loss associated with semiconductor interfaces can be greatly reduced, thus contributing to dramatic performance improvements and cost reductions in electronic control chips used for wide-gap semiconductor elements, such as SiC, GaN, LED and semiconductor laser.

Specific Content:

Thermohydrodynamic, electrochemical, or electromagnetic phenomena associated with interfaces in various energy devices and systems determine the function and performance of the devices. Moreover, most of the energy loss that prevents maximum theoretical performance (limit performance) in energy technology from being realized occurs in these interfaces. To resolve this issue, we are undertaking basic research to achieve breakthroughs in the transport processes of energy carriers that intermediate between phase interfaces (such as atoms, molecules, chemical species, ions, electrons, photons, and phonons) and in elementary processes involved in conversion to another carrier. We are also conducting basic research to develop the design technology required for optimization, control, and manufacture of phase interfaces. In particular, the following broad categories of research approaches are envisioned.

Approach 1: Breakthroughs in phase-interface processes and elementary processes_

- Energy carrier flow: Conduction, diffusion, radiation, evaporation, sublimation, chemical reaction, charge transfer, dissolution, coagulation, precipitation, scattering, reflection, etc.
- Interface morphology: Two-phase/three-phase interfaces, p/n bonding, Schottky junction, heterointerface, quantum dot, etc.
- Nonideal conditions: Defects, impurities, degradation, oxidation, erosion, corrosion, abrasion, distortion, fouling, etc.

Approach 2: Development of design technology for optimization, control, and manufacture of phase interfaces

- Multivariable optimizations such as selection of interface constituent materials, interface morphology (shape/configuration, cavities, fine particles, thin film, coating, porousness) reaction processes, and interface deformation performance (elasticity, viscoelasticity)
  - Loss reduction by means of flow control in multiscale energy carriers

Approach 3: Upgrading of measurement technology and modeling/simulations to support the above two approaches.

- Measuring technology to achieve breakthroughs in the mechanisms of micro-, meso-, and macroprocess phenomena
- Multiphysics/multiscale phenomenal numerical simulations and mathematics based on elementary process modeling

Policy Positioning (positioning within the policy system and necessity/urgency in terms of policy etc.):

Green Innovation (innovations in the field of environmental energy) was established in the new growth strategy (approved by the Cabinet in June 2010) as one of the forces driving growth. The objectives are to expand and advance Japan’s top-level environmental technology and become the world’s most advanced country in the fields of energy and environment. Green Innovation includes global warming countermeasures intended to reduce greenhouse gases by 25% by the year 2020. The Growth Strategy Implementation Plan (progress schedule) calls for the promotion of advanced energy usages to reduce our carbon footprint.

The report entitled "Basic Policies for Science and Technology" issued in December 2010 by the Council for Science and Technology Policy, Cabinet Office, forecasts that "Problems with constraints on resources and energy (omission) will, in the mid- and long-term, become serious and critical worldwide. For this reason, we must lead the world in surmounting these problems and advance research related to 'energy conservation technology development' as part of the promotion of highly-efficient and smart energy usage."

Furthermore, the "2011 Science and Technology Critical Measures Action Plan" (July 2010) states that "with regard to converting to low-carbon energy supply and usage" or "reduced energy usage," it is necessary to "engage in a multifaceted deployment of a wide range of technologies, maximize the potential for reducing greenhouse gas emissions inherent in these technologies, and conduct research development and promote initiatives required for introducing and expanding these technologies according to their respective characteristics." In particular, the report points out the need to go back to basic research and conduct leading-edge innovative research and development for items, such as solar cells, storage batteries, and fuel cells, presented in the implementation package.

Coordination with related policies, Division of Roles, and Differences in Policy Effects:

In research and development projects related to energy conversion conducted by the New Energy and Industrial Technology Development Organization (NEDO), the necessity of going back to basic research in the field of interface science was pointed out, and it is anticipated that the results of the return to basic research conducted for this Strategic Object will be utilized. In particular, it is required to improve the durability of solid oxide fuel cells electrolyte membrane and electrolyte catalyst and develop nonprecious metal electrolyte membrane for polymer electrolyte fuel cells that can withstand wide temperature ranges and low humidification. For this purpose, basic research is required related to breakthroughs in deterioration mechanisms at phase interfaces for electrolyte membranes and electrocatalytic layers. For secondary batteries as well, there is a need to go back to basic science and produce breakthroughs in mass transport and reaction mechanisms between electrodes and catalysts to drastically improve performance and reliability and reduce costs by a wide margin. For catalytic reaction systems including photocatalytically generated hydrogen, elucidation of phenomena under actual severe conditions, such as by means of on-site monitoring, using high level measurement and analysis methods is a key issue. In addition, it is becoming extremely difficult to upgrade low-grade fuels and process impurities for high-efficiency thermal power generation. Therefore, it is required to elucidate the heat/mass transport phenomena occurring in and between various types of phase interfaces, such as multiphase flows, wall surfaces, and catalysts.

As part of research and development related to interface controls, the Ministry of Education, Culture, Sports, Science and Technology (MEXT) held the Program for Development of Environmental Technology using Nanotechnology that was open to the public. In the relevant programs, base facilities extracted demander's technical needs cooperatively with industries. By constructing joint research bases in which researchers from government, industry, and academia are assembled, leading-edge computational science and measurement technology can be leveraged to resolve issues. In addition, from a long-range perspective, these bases will serve to foster human resources responsible for conducting Japan's nanotechnology research.

This Strategic Object emphasizes the understanding of energy and mass transport/reaction in phase interfaces from the kinetic standpoint, including research on materials that comprise phase interfaces. In addition, by considering issues that require a return to basic research in projects conducted heretofore, such as those by NEDO, as main targets, we intend to create the seeds of new technology from research development related to phase-interface phenomena. These phenomena cover nano-, meso-, and macroscales that will contribute to the solution of energy-related problems. Further, we expect that the above-mentioned implementations will be in a complementary relation with objectives and research contents, resulting in collaborations such as sharing of research results.

Scientific Justification for the Research and Development Goals (need, urgency, achievability etc. based on domestic and international research trends):

According to "International Comparison of Nanotechnology/Materials, Science and Technology/Research and Development 2009" (JST Center for Research and Development Strategy, May 2009), "The field of energy/environment is directly connected to progress in materials science, making it necessary to achieve synthesis of nanotechnology and materials technology because these sectors have the potential for groundbreaking technological development."

In addition, "as typified by the JST nanotechnology-related projects, basic research in interface/surface science and technology covers a wide range of fields, such as physics, chemistry, materials science, and polymers, thus leading to beneficial research results. (Omission) Basic research does not necessarily have to be "true" basic or foundational research, and in most cases, it does not result in new research or innovative technology developments. "

In terms of international trends, Germany has led the way in attaching high importance to phase-interface science, and in November 2007, the country established "the Smart Interface Center" as "a core research facility (Cluster of Excellence)" to conduct internationally competitive research under the Federal Excellence Initiative. At this facility, researchers in five branches of science, i.e., chemistry, materials science, mathematics, mechanical engineering, and physics, collaborate to swiftly engage in achieving advances in the understanding and design of phase interfaces.

At the workshop entitled "Phase-Interface Science Supporting a Society Using High-efficiency Energy" conducted by the JST Center for Research and Development Strategy in August 2010, researchers from diverse fields examined specific R&D issues and promotion measures as well as reconfirmed the importance and necessity of advancing phase-interface research to make dramatic performance improvements in secondary batteries, fuel cells, thermoelectric conversion, and photocatalytic hydrogen production.

Furthermore, it was determined that an effective method for generating new breakthroughs is to enable chemistry researchers proficient in phenomena elucidation and materials development as well as mechanical system researchers with advanced skills in system realization to closely collaborate and share data while focusing on the goal of ultra-high efficiency energy usage.

Background to Deliberations:

To advance research effectively and efficiently in terms of the overall project, it is necessary to establish linkages with research areas related to this Strategic Object. This includes multidisciplinary research areas (those related to nanotechnology and mathematical science) such as the CREST research area (Development of the Function of Nanointerface Technology).

5.1.7 Creation of basic technologies for utilizing plant photosynthetic functions and biomass that will enable the actualization of efficient carbon dioxide utilization

Targets to Achieve:

○ Development of an integrated understanding of photosynthetic functions and to create basic technologies required to improve the efficiency of photosynthesis based on this understanding

○ Creation of basic technologies to improve carbon storage and to develop high-quality biomass derived from breeding research and functional analysis of diverse plants that adapt to a range of environments

○ Creation of basic technologies for improving efficiency and upgrading biomass usage by means of elucidations in biomass decomposition/metabolism as well as from the utilization of technologies, such as genome synthesis technology

Vision for Reaching Achievable Important Goals in Future:

This Strategic Object is primarily concerned with utilizing, in collaboration with researchers in other fields, the results of plant science research focused on photosynthesis and biomass production and advancing the development of innovative technology to utilize carbon dioxide as a resource and utilize biomass more efficiently. These efforts are to involve drastically improving existing technology as well as securing innovative technology that will produce new breakthroughs.

Under this Strategic Object, by utilizing elucidations of photosynthetic functions derived as a result of research, we aim to create the basic technology required to utilize carbon dioxide as a resource through plants. This will be accomplished by improving photosynthetic efficiency and increasing biomass production as well as by diversifying and upgrading the technology of biorefineries. Linking these research results with research networks of universities and the experimental empirical/practical research conducted by companies, etc., we aim to develop biomass crops with superior carbon-fixation properties and tolerance for adverse environmental conditions and to develop efficient biomass application technologies by adopting new micro-organisms and enzymes for decomposition.

To further expand technologies developed for this Strategic Object, to achieve reductions in the carbon content of our energy supply, and to realize high-efficiency and smart energy usage, the technologies must be proven and widely disseminated to the society at large. To achieve this, we need to link research under this Strategic Object and measures and policies related to verification of the effectiveness of green innovation in the society, exchange of technological development research with the private sector, and acceleration of technological assistance to developing nations.

By lowering costs and diversifying biorefineries and establishing and disseminating distributed energy systems using biomass energy by such means, we aim to accomplish the key tasks required for the realization of Green Innovation, namely, “reduction of the carbon content in the energy supply” and “conversion to high-efficiency and smart energy usage”. Furthermore, we aspire to contribute to the realization of a sustainable society responding to climate change.

Specific Content:

The fourth assessment report by the Intergovernmental Panel on Climate Change (IPCC) declared that global warming which occurred in the second half of the 20th century was extremely likely to have been caused by a buildup in greenhouse gases because of emissions associated with human activities such as burning of fossil fuels and predicted that global temperatures would continue to rise. To curb such a global warming and build a sustainable society that is not reliant on fossil fuels, it will be necessary to secure renewable sources of energy and undertake a fundamental shift in our material production systems. For this Strategic Object, based on the augmentation of carbon-fixation properties through photosynthesis, we intend to deal with the aforementioned problems by promoting biomass utilization and carbon dioxide utilization as alternatives to fossil fuels. We aspire to make strategic progress in the reduction of carbon dioxide emission and conduct basic research related to the adoption of carbon dioxide as sustainable resources.

In terms of specific research content, we envision the following:

○ Development of an integrated understanding of photosynthetic functions and create basic technologies required to improve the efficiency of photosynthesis based on this understanding
- Analysis of chloroplast metabolic systems by using a comparative genome analysis
- Improvements of carbon metabolic processes and carbon fixation efficiency

○ Creation of basic technologies to improve carbon storage and to develop high-quality biomass derived from breeding research and functional analysis of diverse plants adapted to a range of environments
- Analysis of control networks of metabolism by integrated omics analysis such as metabolomics
- Improvement of C3 photosynthetic functions and the introduction of C4 photosynthesis to C3-type photosynthetic plants
- Research to optimize photosynthetic sink and source
- Improvements in biomass production by genome design and molecular breeding and the creation of new biomass plants

○ Creation of basic technologies for improving efficiency and upgrading biomass usage by means of elucidations in biomass decomposition/lipid synthesis systems
- Improvements in biomass utilization efficiency by research of breeding biomass-degrading micro-organisms and development of new enzymes
- Research and development of new materials linked to plant breeding and materials chemistry/engineering
- Creation and functional enhancement of new bioplastic materials subsequent to that of polyactates

Policy Positioning (positioning within the policy system and necessity/urgency in terms of policy etc.):

This Strategic Object makes contributions to “Strategic Advancement of Renewable Energy Technology Research and Development of Biomass Utilization” included in “Reducing Carbon Content of the Energy Supply” in the report “Basic Policies Regarding Science and Technology” (Council for Science and Technology Policy, December 2010).

It also serves to further disseminate woody biomass thermal utilization, air-source heat utilization, and earth/solar hot water utilization as stated in “I. National Strategies for Green Innovation” contained in the New Growth Objectives (approved by the Cabinet in June 2010). In addition, it makes contributions to “Promotion of Low Carbon-Type Industry Sitting and Promotion of Initiatives for Transitioning to Global Bases,” “Promotion of Resource Energy Storage Strategies,” and “Front Loading Development of Innovative Technologies, Prioritization of Focus (CCS [Carbon Recovery/Storage], Nuclear Power, Next Generation vehicles, Biorefineries, Floating Wind Turbines, etc.)” as stated in the Growth Strategy Implementation Plan (Progress Schedule).

Contributions are also made in connection with the following sections of the “Green Innovation” Chapter of the “2011 Science and Technology Critical Measures Action Plan(July 2010): “Research and Development for Innovative Production Technology for Large-Scale Introduction of Woody Biomass that does not Compete with Foodstuffs” included in “2.3 Issue Resolution Action Items” as well as “Objective Basic Research for

Woody Biomass Usage Technology" (MEXT) included in the implementation package, "Research and Development of Technology using Woody Biomass".

Moreover, there are contributions to the following sections of "Basic Plan to Promote Biomass Utilization" based on the fundamental law on the promotion of biomass utilization approved by the Cabinet in November 2010, i.e., "Creation of Businesses that Supply Biomass or Biomass Products" and "Promotion of Biomass Products, etc.," included in "Integrated and Planned Measures the Government Must Implement Regarding the Promotion of Biomass Utilization." In addition, "The Development of Efficient Glycation Technology for Cellulose (Woody) Biomass and the Development of Fermentation Technology to Produce Diverse Raw Chemical Products Other than Ethanol" and "The Development of Technology related to Low-Cost Production Technology, Heat Resistance and Durability for Expanded Dissemination of Biomass Plastics" are included in "Technical Issues that Must be Resolved in the Mid-Term to Achieve High-Level Biomass Utilization."

Coordination with related policies, Division of Roles, and Differences in Policy Effects:

An analysis infrastructure that contributes to the research falling under this Strategic Object will be developed through the Leading-Edge Research Infrastructure Program, "Developing Infrastructure for Advancing Plant Research to Realize a Low-Carbon Society". Further, the "University-launched Green Innovation Creation Project" will establish university and other research networks centering on plant science research to advance green innovation. This Strategic Object leverages the foundations developed by Leading-Edge Research Infrastructure Program (developing infrastructure for advancing plant research in order to realize a low-carbon society) by utilizing the results of research in diverse biological functions, which was conducted using model organisms, and analyzing diverse species that may be suitable for efficiently utilizing carbon dioxide as a resource and expanding biomass production.

With regard to biomass utilization technology, along with the maximum utilization of research results from previous projects in the creation of biomass fuel, problems and issues will be extracted and technologies focusing on a long-term view will be advanced. Furthermore, by forming linkages with research networks from universities and other institutions established by "University-Launched Green Innovation Creation Project", the results of research projects related to plant photosynthetic functions and biomass can be shared, thus accelerating the development of carbon dioxide utilization technologies.

Scientific Justification for the Research and Development Goals (need, urgency, achievability etc. based on domestic and international research trends):

The fourth assessment report on the Intergovernmental Panel on Climate Change (IPCC) estimated that 20% of artificial carbon-dioxide emissions is because of activities such as deforestation. The report highly valued the synergistic effects and future potential of biomass energy strategies as a part of global warming adaptation and mitigation measures, and it predicted that improvements in technologies to utilize carbon dioxide through photosynthesis would contribute significantly to the realization of a low-carbon society. Moreover, the IEA's 2010 World Energy Outlook also predicted a rapid rise in the utilization of biomass fuels.

The level of Japan's basic science and technology in the field of plant research, including growth control and morphological analysis related to photosynthetic metabolism networks and biomass production, as well as research in plant environmental adaptation and stress tolerance is equal to or surpasses that of Western countries. Further, other Asian countries are making efforts to improve biomass and crop production, thereby making it essential that Japan secure a position of research leadership in Asia.

In Japan, it is anticipated that contributions to technologies enhancing biomass production in the future will be made, considering that significant advancement using model organisms was seen in the integrated analysis of hormonomes, which targeted hormones that play a major role in growth control, and metabolomes, which is a comprehensive analysis of metabolites related to the production of useful materials. Furthermore, Japan is also the world leader in research related to tolerance for adverse environments such as arid, hot, saline, and acidic soils and research related to resistance to infection and pests. It is expected that these research results will develop and expand.

In particular, with regard to utilization of carbon dioxide as a resource, it is expected that significant results of research by model experiment systems involved with increasing the efficiency of photosynthesis based on breakthroughs in chloroplast function as well as breakthroughs and utilization of metabolism control networks related to carbon fixing and biomass production will prove effective. This knowledge, however, has not yet resulted in realizing gene modifications of non-model plants related to energy and biomass crops. To develop practical applications, it is necessary to have genome design technology that is able to appropriately and rigorously control introduced genes. In future, research and development to realize genome design for introduced genes and improvements in genetic transformation are required to improve biomass production. Moreover, based on the analysis of genome information founded on plant diversity, elucidations and applications for utilizable genetic networks adapted to environmental changes are also critical issues in the long term.

Furthermore, in terms of carbon dioxide utilization, research on the utilization of biomass that immobilized carbon dioxide is essential, and along with conducting research on biomass energy usage, research into replacements of raw materials for chemical products made from petroleum is also required. Bioplastics such as polyactates have been put to practical use, but there has not been commensurate progress on new bioplastics that can withstand sufficient heat to be used on equipment such as copy machines and personal computers. By conducting such research and development activities, we can take international initiatives in the field of environmental research.

Other:

To advance research activities that fall under this Strategic Object, it will be necessary to synthesize research from different fields in science, agriculture, and engineering.

In addition, collaboration must also be formed with related research domains and leading-edge carbon technology research, including CREST and PRESTO area (Creation of Basic Technology for Improved Bioenergy Production through Functional Analysis and Regulation of Algae and Other Aquatic Microorganisms). It is necessary to make progress in effective and efficient research in terms of the overall project.

5.1.8 Creation of the basic technologies for comprehending marine ecology highly efficiently and forecasting marine life changes to conserve and regenerate marine biodiversity for sustainable usage of ocean resources

Targets to Achieve:

○ To develop sensing and gene analysis technologies for significantly improving the efficiency and accuracy of marine species quantification and identification for sustaining biodiversity

○ To develop ecological modeling and monitoring technologies needed to ascertain changes in the quantity of living marine resources and marine biodiversity because of the effects of resource/energy development and natural disasters

Vision for Reaching Achievable Important Goals in Future:

Although the conservation of biodiversity as well as the utilization of marine ecosystem services are required for the sustainable use of living marine resources, academic knowledge, basic technology, and the accumulation of fundamental data in this field is currently inadequate.

The results of the research that falls under this Strategic Object will be utilized by the relevant government ministries such as the Ministry of Agriculture, Forestry and Fisheries of Japan, which manages aquatic resources, the Ministry of Economy, Trade and Industry, which is responsible for resource and energy development, and the Ministry of the Environment, which coordinates biodiversity measures, and organizations as local public agencies. This will result in the following accomplishments:

- Systematic accumulation of marine ecology data, which is currently very inadequate, by improving the efficiencies of marine species quantification and identification that have heretofore been extremely challenging
- Creation of modeling and monitoring methods to ascertain and predict variations in biological diversity due to changes in the ocean environment will enable improvements in the accuracy of aquatic resource quantity forecasting and the upgrading of environmental impact assessments

By such means, we can contribute to the attainment of key objectives that Japan has adopted such as "the greening of society's infrastructure" and the "advancement of solutions to global-scale problems." These objectives will include, for example, effective implementation of marine environment conservation measures for establishing marine conserves, appropriate management of marine resources, development of marine resources to conserve marine biodiversity, improvement of measures to ascertain the impacts of large-scale natural disasters such as earthquakes and tsunamis on marine ecology, and implementation of rapid ecological restoration.

Specific Content:

Japan is a maritime nation surrounded by ocean on four sides and possesses a vast exclusive economic zone (EEZ). Because 14.6% of all marine species exist in this EEZ, the zone has attracted attention as a biological diversity "hotspot." In addition, in October 2010, COP10 (10th meeting of the Conference of the Parties to the Convention on Biological Diversity) was held in Nagoya, and subsequently in March 2011, the Ministry of the Environment published the report "Strategies to Conserve Marine Diversity" that recommended the upgrading of information infrastructure and the enhancement of marine conserves.

According to the report "The Economics and Ecosystems of Biodiversity" issued by the UN Environmental Program (UNEP) in October 2010, the economic losses resulting from disruptions of worldwide ecosystems (including terrestrial ecosystems) amount to up to 4.5 trillion dollars per annum. Furthermore, Japan's marine industry, including fishing, seafood processing, and marine leisure, is valued at 16 trillion yen per annum. Hence, the impact of any loss of biodiversity that would diminish the marine industry would be significant.

Because of the impacts of expanding societal and economic activities, global warming, and excessive harvesting of aquatic resources, degradation of marine ecologies such as the loss of seaweed beds and mudflats as well as oligotrophication and eutrophication have increased. It is concerned that these degradation of marine ecologies makes marine resources more exhausted and global environment worse and affect societal and economic activities through various aspects. Furthermore, to continue the economic development of Japan in the future, it will be necessary to conserve marine biodiversity and more effectively utilize marine resources. For example, with rare metals and crude oil becoming scarcer, the development of energy and mineral resources will become increasingly critical. The "Marine Energy/Mineral Resources Development Plan" (approved by the Headquarters for Ocean Policy in March 2009) states that the commercial utilization potential of these resources is being examined with the goal of commercial usage by 2018. The methodology to evaluate the effects on marine environment, such as marine biodiversity, if these developments were to actually occur in the future is now being developed. In future, it is assumed that international rules governing the preservation of biodiversity will become stricter, as was the case with restrictions on greenhouse gas emissions, thus making it imperative that the technological development required to address these issues be conducted in advance.

Against this backdrop, the insufficiency of basic data and knowledge on subjects such as how diverse organisms in coral reefs and mudflats sustain a complex ecology and how ocean species are concentrated and distributed becomes a critical issue. Moreover, the technology to grasp and forecast changes in marine ecology is also inadequate. The reasons for this inadequacy are that it is more difficult to access marine environments than land environments. In addition to equipments (i.e., research ships) that are required, the marine biosphere differs from the terrestrial biosphere in that there are vast expanses in the vertical depth from the surface to the floor of the ocean, the number of species estimated to exist in the sea is greater than that on land, and marine organisms can move within a wide range with the ocean currents.

Therefore, for this Strategic Object, by means of collaboration among specialists from a broad range of scientific fields including marine physics, marine chemistry, marine biology, statistics, ecology, taxonomy, and molecular phylogeny, we aim to improve the basic research and knowledge that will contribute to marine development in terms of sustaining biodiversity and upgrading the following basic technologies:

(1) Development of technologies that will significantly improve the efficiency and accuracy of marine species quantification and identification

(2) Development of technologies to ascertain marine organism quantities and changes in marine biodiversity based on various types of observational data

In particular, the following research subjects have been proposed, but it is expected that other types of research for the development of new technologies will also contribute to the attainment of this Strategic Object.

Research and Development issues

(Development of technology that will improve the efficiency and accuracy of marine species quantification and identification)

- Development of technology to understand prey-predator relationships from stable isotope ratios, etc.
- Development of DNA bar-coding technology to create marine species databases.
- Development of measurement technology for the continuous study of marine organisms over a wide area.

(Technology development to understand fluctuations in marine resources and marine biodiversity)

- Development of the technology required to ascertain and analyze biodiversity conditions that are necessary for establishing marine reserves.
- Development of numerical models to comprehend ecological fluctuations that take into account species' food chains.
- Development of marine biodiversity monitoring methods using remote sensing.

Policy Positioning (positioning within the policy system and necessity/urgency in terms of policy etc.):

The “Basic Plan on Ocean Policy”, which was based on the “Basic Act on Ocean Policy” enacted in July 2007 and was approved by the Cabinet in March 2008, declared the necessity of making efforts to conserve marine biodiversity, and further stated that “it is essential to develop the scientific knowledge related to ecology, pollutant, etc. of the marine environment.”

The “National Biodiversity Strategy 2010” that was based on the “Basic Act on Biodiversity Policy” enacted in June 2008 was approved by the Cabinet in March 2010.

In this document, it is stated that “the data which is the basis for measures and policies to conserve marine biodiversity is lacking. Therefore, it is necessary to collect and upgrade this information, and to advance scientific conservation measures and policies,” making the point that from the start the fundamental data and knowledge required to discuss the conservation of biodiversity is insufficient. In addition, based on these National Strategies, the Ministry of the Environment published in March 2011 a report entitled “Marine Biodiversity Conservation Strategies” that stated as an objective “the need to conserve the biodiversity which supports the healthy structures and functions of marine ecology, and utilize marine services (ocean bounty) in ways that are sustainable.”

The “Growth Strategy Implementation Plan (Road Map)” that is part of the “New Growth Strategy” was approved by the Cabinet in June 2010. In section “I. Environmental/Energy Powerhouse Strategies” of the Implementation Plan, it was stated that “progress in the development and dissemination of marine resources/marine renewable energy, etc.” should be realized by 2020.

In addition, according to “2011 Key Science and Technology Policies Action Plan,” compiled in July 2010 by the Council for Science and Technology Policy, which indicated the necessity of “the establishment and international application of biodiversity preservation technology that responds to climate change” in terms of “the greening of society by utilization of earth observation data.”

In the report “Basic Policy on Science and Technology” (Council for Science and Technology Policy, Cabinet Office, December 2010), it was pointed out that for “the greening of societal infrastructure,” “the information obtained from earth observations, forecasts, and integrated analysis represents the essential societal/shared infrastructure required to advance green innovation, (omission)… as we work to make advances toward the preservation of the natural environment and biodiversity and the development of recycling-oriented food industries.” The report also stated that as part of the “response to key issues that Japan faces,” “in order to conserve biodiversity, we will advance research and development in ecology-related studies and observations, in the evaluation of external-factor impacts, and in conservation/regeneration measures.”

At the COP10 conference that was held in Nagoya City in October 2010, 20 goals were adopted as “Aichi Target.” These included improvement, widespread sharing and application of knowledge, scientific foundations, and technology related to biodiversity, its values and functions, its current status and trends, and the effects of its loss. A pressing concern was the establishment of methods to conserve biodiversity by the 2020 time limit set for achieving the Aichi Target.

In August 2010, the report of the international project “Census of Marine Life” made it clear that the EEZ which surrounds Japan on four sides possesses the world’s richest biodiversity.

Even in terms of conservation of global biodiversity, preserving 15% of the world’s species that are living in the waters surrounding Japan is pivotal.

Coordination with related policies, Division of Roles, and Differences in Policy Effects:

The objective of the “Program to Advance the Technology for Marine Resource Utilization,” which commenced in fiscal 2011, is the upgrade of the basic technologies that contributes to food supply stabilization, and differs from this Strategic Object that has the goal of understanding and measuring biodiversity.

In addition, the Japan Agency for Marine-Earth Science and Technology conducts research related to biodiversity in order to understand global systems in general, and especially focuses on understanding the deep seabed ecosystem by such means as the submersible research vehicle "Shinkai 6500." Research that is conducted utilizing such technology and equipment can be linked to this Strategic Object.

Since fiscal 2008, the Ministry of Agriculture, Forestry and Fisheries has been promoting the "Project for Integrated Measures to Conserve Fishing Ground Environments/Biodiversity" in regard to the conservation of biodiversity and its application. The main objective of this project is the development and evaluation of technology from the aspect of fishery environments. This includes reinforcing the prevention and monitoring of red tides and anoxic water masses as well as environmental impact assessment on fishing ports and fishing grounds.

The Ministry of the Environment is conducting research development related to ecological preservation and regeneration in "Environment Research and Technology Development Fund".

In terms of an adopted marine issue, concerns related to the study and preservation of coral reefs, which attract the attention of society because of their rarity and scenic beauty, are of key importance. Also, the Ministry of the Environment issued the report "Strategies to Conserve Marine Biodiversity" in March 2011, and linkages are expected to be formed with MEXT regarding research studies and technology development.

With these developments taking place, the concern of this Strategic Object is the basic research that focuses on fundamental technology among technologies such as the new gene technology required to comprehend biodiversity, marine environments evaluation technology, and technology to forecast changes in marine ecology. The knowledge and technology obtained through this Strategic Object will enable the more effective and efficient implementation of the above-mentioned measures and policies of the other ministries.

It should be noted here that the establishment of technology for utilizing and managing marine resources while sustaining marine biodiversity will take decades of research.

Accordingly, in order to continue making steady progress in resolving the issues that Japan is confronting, we will need to conduct sustained and long-term research linked to related policies and measures

Scientific Justification for the Research and Development Goals (need, urgency, achievability etc. based on domestic and international research trends):

- The Japan Science and Technology Agency (JST) held the "Ecology and Biodiversity Research and Development Program Aiming at Sustainable Development" in April 2005, at which critical research subjects were extracted and studied.
- In addition, between August 2005 and February 2006, investigation teams were dispatched by JST to the U.S., the Netherlands, the U.K, and Norway to study the efforts being made by other countries for dealing with these critical issues, and to narrow down and prioritize issues from Japan's research trends, etc.
- The report "Preservation and Sustainable Utilization of Biodiversity: Recommendations from Academia" (Science Council of Japan, February 2010) also pointed out the need for "the long-term collection of broad-based biological and ecological data."
- In January 2011, the Marine Biology Panel based on the Marine Development Subcommittee of the Council for Science and Technology issued the report "The Importance of Marine Biodiversity Research" regarding the importance of academic investigations into biodiversity.
- In December 2007, the European Parliament adopted Marine Strategy Directives designed to bring the EU Marine Zone environment to a favorable condition.

- As part of those directives, integrated measures and policies related to the preservation of the marine environment, from biodiversity to water contamination, were launched.
- In the U.S., the "Program for Comparative Analysis Related to the Structure of Biodiversity" is being conducted by NSF and NOAA. As part of this program, research related to marine biodiversity is being carried out.

Background to Deliberations:

For the results of the research that falls under this Strategic Object to be shared among the Ministry of Agriculture, Forestry and Fisheries, METI, the Ministry of the Environment, and local government associations, etc. and for those results to contribute to the resolution of Japan's issues, collaboration with the related ministries, etc. through MEXT needs to take place. In addition, to conduct advanced technology research, researchers from a broad range of fields, including those in the marine specialties, as well as researchers from engineering and the life sciences, need to coordinate their research efforts.

Furthermore, research areas falling under this Strategic Object need to cooperate with multidisciplinary areas of study (related to mathematics), etc. so that the research may be effectively and efficiently advanced as one overarching project.

5.2 Life Innovation

5.2.1 Creation of core technologies for early-stage drug discovery through the investigation of disease-specific profiles of biomolecules

Targets to Achieve:

In order to establish novel technologies for drug discovery by making use of knowledge about disease-specific profiles of biomolecules (including primary and secondary metabolites, natural organic compounds derived from microorganisms and those derived from foods), this Strategic Sector aims to achieve the following targets by carrying out multidisciplinary research that merges life sciences with nationally competitive disciplines including nanotechnology, synthetic chemistry and engineering.

- Creation and advancement of technologies to efficiently identify target molecules (proteins and others) interacting with biomolecules of interest, using tools of nanotechnology, synthetic chemistry and other fields
- Creation of technologies to enable identification and regulation of a pharmaceutically valuable pathway, based on the obtained knowledge about disease-specific profiles of biomolecules
- Creation of technologies to identify and detect disease-specific profiles of biomolecules (as biomarkers) toward application to bedside diagnosis of infectious diseases and other disorders

Vision for Reaching Achievable Important Goals in the Future:

In this Strategic Object, the research achievements noted in the Section" Targets to Achieve" will enable research that integrates "Elucidation of disease mechanisms," the search for (genetic) causes of disease, one of the existing primary strategies for deploying the achievements of life science research in life innovation, with "Elucidation of treatment mechanisms," whose goal is to develop disease control technologies. This will enable Japan to be the first country in the world to establish technologies for drug discovery that exploit knowledge about disease-specific profiles of biomolecules.

After the completion of this program, the technologies developed through this research are anticipated to be expanded further and developed by academia, private sector companies etc., leading to practical applications such as the following:

- Establishment of standard methods for screening of target molecules interacting with biomolecules of interest
- Identification of biological activity via multiple pathways and harmful side effects of drugs, by applying the above method to pharmaceuticals and other synthetic compounds
- Establishment of a support infrastructure for drug discovery and development that uses screening of target molecules interacting with biomolecules and compounds of interest
- Creation of technologies for discovering drug candidates based on a new systems approach to determine cellular states, facilitated by new understandings such as the mechanisms of action for physiologically functional biomolecules of interest
- Identification of disease biomarkers by metabolomic profiling of clinical samples
- Diagnosis of infectious diseases, such as identifying pathogens or disease progression, by simple measurements of biomarkers in clinical samples
- Development of functional foods and medicines based on identification of physiologically or pathologically important biomolecules derived from microorganisms, plants and animals

The result of these developments will revolutionize technologies and techniques for drug discovery, diagnosis and treatment, helping to achieve the objectives "Development of innovative preventive care," "Development of new early diagnostic methods" and "Realization of safe and highly effective treatment" in the 4th Science and Technology Basic Plan (approved by the Cabinet on August 19, 2011).

Furthermore, in terms of the life sciences in general, discovery of the biological activity resulting from the synergy produced when one type of biomolecules has multiple points of action, and of undiscovered metabolic pathways and molecular targets.

Specific Content:

(Background)Traditional disease research has focused primarily on causative genes and the genomic information, thereby elucidated the mechanisms. Thus, research has centered on genomic and transcriptomic analyses that focus on changes in sequences and RNA expression levels due to DNA mutations with the aim of elucidating the disease mechanism, and drug discovery based on information on the three-dimensional structure of proteins.

Metabolites are the final products of genomic information and reflect the state of the disease. However, little progress had been made, as no techniques had been established for elucidating its targets and functions. Nevertheless, in recent years, the development of analysis techniques using mass spectroscopy and nuclear magnetic resonance (NMR) spectroscopy has increasingly made this type of research possible, and such post-genomic research is currently attracting a great deal of attention.

In Japan, post-genomic research has been conducted as a result of the establishment in FY 2005 of the Strategic Object "Establishment of basic technologies for controlling of cell functions based on metabolic regulation mechanism analysis" and so on. Specifically, research was conducted using plants or rodents etc. to analyze specific, intracellular metabolic changes and metabolic pathways for the purpose of biologically elucidating the causative genes and signaling molecules etc. relating to the functional mechanism of metabolites, in order to obtain metabolomics profiles in specific cellular states and create a database of existing metabolites and so on. Studies in disease cohorts and searches for comprehensive useful metabolites have also begun on a trial basis, and researchers are beginning to discover information on the expression of metabolites that are useful as disease-specific biomarkers. In this way, research is being conducted in that expression analysis of metabolites results in the identification of biomarkers and the use of information in database form.

In many areas, however, little progress has been made on the specific biological activity of metabolites, as well as their functions in disease states and the controlling factors and mechanisms, and even now the functions of approximately 70% of human metabolites such as amino acids, nucleic acids, sugars and fats have not been annotated. Moreover, there exist inside the human body natural organic compounds that come from intestinal bacteria, indigenous skin bacteria and other microorganisms as well as from plants eaten as food, and they play an essential role in the survival of human beings.

Some of these biomolecules (including metabolites, natural organic compounds derived from microorganisms and those derived from foods) are created specifically at a disease state, including cancer or infectious diseases, and therefore they can be used as disease biomarkers. Molecules that function as medicines in the body also have the potential to lead directly to new drug discovery. In addition, if biomolecules perform an essential function in a disease and other abnormal states or pathogens, target molecules (proteins and others) that can bind to these biomolecules may serve as targets for drug discovery. To this end, using existing research infrastructure, these biomolecules must be an important topic in order to use them for drug discovery or as biomarkers and search for proteins and other target molecules and elucidate their control mechanisms.

(Research contents)In the course of this research, existing knowledge of disease-specific gene products (RNA and proteins) should be utilized, while at the same time working to fuse and link the life sciences with nanotechnology, synthetic chemistry, engineering and other technologies that are Japan's strengths. For example, close cooperation should be established between research into technologies to identify targets of small molecules by means of affinity columns, beads or other tools that utilize nanotechnology and synthetic chemistry, and genomics and other omics studies in the life and medical sciences, in order to develop technologies, etc. needed to achieve "medical care driven by research (and researchers) on compounds and synthetic pathways."

The following specific research content is envisioned.

- Creation and advancement of technologies to efficiently identify target molecules (proteins and others) interacting with biomolecules of interest, using tools of nanotechnology, synthetic chemistry and other fields
  - Creation of technologies including those to efficiently purify proteins and other target molecules that can bind to biomolecules of interest
  - Development of technologies, as an application of the aforementioned ones, to isolate and purify disease-specific biomolecules and their associated enzymes and transporters in specific cases such as cancer, infectious diseases, lifestyle-related diseases, neurological diseases, and immune and inflammatory diseases
- Creation of technologies to enable identification and regulation of a pharmaceutically valuable pathway, based on the obtained knowledge about disease-specific profiles of biomolecules
  - Creation of technologies to identify disease-specific profiles of biomolecules and their mechanisms of action, through the integration of metabolomic analysis of clinical samples with genomic, epigenetic, and related investigations, in specific cases such as cancer, infectious diseases, lifestyle-related diseases, neurological diseases, and immune and inflammatory diseases

- Verification of disease control concepts with animal models that mimic an *in vivo* environment for substrates, enzymes, metabolites and other related molecules

- Creation of technologies to identify and detect disease-specific profiles of biomolecules (as biomarkers) toward application to bedside diagnosis of infectious diseases and other disorders
  - Creation of technologies to profile metabolism in disease states and to identify biomarkers, by means of metabolomic analysis of clinical samples including but not limited to blood, saliva, and urine
  - Creation and instrumentation of methods and technologies to sensitively measure (comprising steps such as sample pretreatment, measurement, and data processing) and quantify disease-specific biomolecules using clinical samples

Policy Positioning (positioning within the policy system and necessity/urgency in terms of policy etc.)

The 4th Science and Technology Basic Plan, under "Development of innovative preventive care," states that "Preventive care based on objective grounds (evidence) will be developed by identifying the mechanisms that govern the onset and development of lifestyle-related diseases, etc. ... through the promotion of cohort studies, such as analysis of clinical data, metabolome, and gene sequences." In addition, under "Development of new early diagnostic methods," the plan states that "...development of high precision early diagnosis technologies will be promoted, including development of new detection methods and equipment that contribute to early diagnosis, such as technologies for identifying trace substances, and searching for and identifying new markers." And under "Realization of safe and highly effective treatment," the plan states that "In the development of new medicine, new drug targets need to be searched for by analyzing disease mechanisms and treatment with models using animals, iPS cells and others. To this end, basic studies in the life sciences will be promoted."

An effective way of achieving these objectives is thought to be the pursuit of research targeting for biomolecules that can be used for diagnosing and determining the progress of cancer and infectious and other diseases by means of quantitative measurements, can be used as biomarkers, and can even become the seeds of new drug discovery. Japan's technologies for achieving innovative drug discovery screening methods in particular are essential for domestic researchers and pharmaceutical companies, etc. to stay internationally competitive and to continue to produce the seeds of new drug discovery. Research must be pursued into technologies to identify the target molecules of biomolecules that are the objective of this Strategic Object, as crucial technologies that can become the core of this effort.

Coordination with Related Policies, Division of Roles and Differences in Policy Effects:

The high throughput screening system using compound libraries is a drug discovery technology that is now in widespread use. Development and advancement are being conducted on a concentrated basis through the Leading-edge Research Infrastructure Program entitled "Establishing a Cutting-edge Research and Education Base for Drug Discovery Utilizing a Chemical Compound Library," Platform for Drug Discovery, Informatics, and Structural Life Science of the Ministry of Education, Culture, Sports, Science and Technology and other projects. In addition, technologies, facilities and equipment are being shared and support for drug discovery research is being provided. In this Strategic Object, these resources are being used while pursuing research into the discovery of new core technologies for the efficient identification of biomolecules and proteins and other target molecules that will lead to drug discovery.

Moreover, in research involving biomolecules, biomarker search projects that use mass spectrometry and comprehensive search centers are indispensable efforts, and domestic research institutions such as the Institute for Advanced Biosciences at Keio University and the Integrated Center for Mass Spectrometry at Kobe

University are beginning to conduct autonomous efforts. At this stage, however, the standard methods and technologies and pretreatment methods needed to conduct large-scale comparative analysis of biomolecules through collaboration with many facilities have not yet been established, so integrated analysis of the blood, saliva, urine and other samples collected at many facilities is not possible. For this reason, new technologies are needed, and standard technologies for conducting biomolecules analysis will be developed in this Strategic Object. Moreover, in order to collaborate with many facilities for this purpose, technologies that doctors in clinical settings can use and analyze quickly and easily are needed. Accordingly, technologies for identifying and detecting biomolecules (biomarkers) that reflect disease states, for use in making diagnoses in clinical settings, will be developed in this Strategic Object, contributing to an "All-Japan" analysis effort.

In this way, the project will be promoted both effectively and efficiently by making it a mutually complementary effort with the existing large-scale projects already being promoted by several research institutions, in which comprehensive searches are being conducted for disease-specific profiles of biomolecules.

Scientific Justification for the Research and Development Goals (need, urgency, achievability etc. based on domestic and international research trends):

According to a report*[1] by the Center for Research and Development Strategy of the Japan Science and Technology Agency (JST/CRDS), an infrastructure is being established, primarily in the United States and Europe, for metabolomic research based on the analysis of biomolecules. In Europe, the Metabolomics Centre was established at Leiden University in the Netherlands in 2008 (approximately JPY 5 billion over a five-year period). Next, national metabolomics projects were started up in 2010 in Germany and France. In North America, approximately JPY 700 million was provided in 2012 to the three existing metabolome centers at the National Institutes of Health (NIH) in the United States, and subsequently a plan to invest approximately JPY 2.8 billion in the next five years was announced. In Canada as well, approximately JPY 750 million was invested in 2003 to set up the Human Metabolome Project at the University of Alberta. In Australia, Metabolomics Australia set up research nodes at five universities in 2007 (approximately JPY 8 billion over a five-year period). In this way, various countries have recognized the importance of metabolomic research, and there has been active research investment particularly in the past few years, focusing primarily on research and development of the correlation with cancer and other diseases.

With this background, a look at the many research papers that have been published reveals that, in 2012, Japan held the third largest share of papers published that included the word "metabolo*" (following the United States and Germany).*[2] However, the JST/CRDS report*[1] stated that "In basic research fields, although Japan is strong in terms of individual technologies such as mass spectrometry analysis, overall there is a large gap between Japan and other countries such as the United States. This trend is even greater in the area of applications, and it is feared that there will be a drop in competitiveness in the future."

In the field of chemical biology, which is related to the drug discovery core technologies that are based on metabolomic analysis, as well, the JST/CRDS report*[1] states that currently "Japan has fallen considerably behind Europe and the U. S." Several reasons for this have been identified, and the report points out that "the fact that fields are segmented vertically in Japan because of academic societies so the foundation for promotion of cross-cutting research has not been established, and that therefore there has not been sufficient training of personnel to carry on research in the field of chemical biology, cannot be ignored."

Japan has notable strengths in the field of synthetic chemistry, as evinced by the fact that it has received Nobel Prizes in the field, and in the past few years original Japanese technologies for target molecule identification have been developed by synthetic chemistry researchers at universities and research institutes.

Under these circumstances, from a policy standpoint, it is vital that such researchers be invited to enter the fields of medicine and drug discovery research and pursue research that fuses chemistry, engineering and biology. This will produce achievements that will maintain Japan's international competitiveness in the pharmaceutical industry and other industries, and at the same time build a foundation that includes personnel training.

Currently, only Japan, Europe and the United States have the ability to develop new drugs, and Japan is the only country in Asia that has developed new pharmaceuticals. Research based on metabolomic analysis has the potential to lead to new drugs and other breakthroughs, through the discovery of a single factor. Quickly launching research efforts in this Strategic Object will make it possible to better maintain Japan's advantages over the other Asian countries that are experiencing remarkable economic growth.

*[1] "Global Comparison of Science & Technology and Research and Development in the Life Science Field 2012," JST Center for Research and Development Strategy, 2012"

*[2] Thomson Reuters "Web of Knowledge" (http://wokinfo.com/)

Based on the number of original papers in 2012 returned by a search (keyword: metabolo*).

Background to Deliberations:

At the Life Science Committee of the Council for Science and Technology (April 20, 2012), multiple discussions were held on the topic of "Future research issues relating to life innovation." As a result, metabolomic research was indicated as a research topic necessary for "Development of new early diagnostic methods" and "Realization of safe and highly effective treatment," and there was a desire to deploy this to research on metabolism and other areas of medicine. Based on these discussions, the JST-CRDS Metabolic Research Workshop was held by JST/CRDS on July 13, 2012, with the goal of achieving interdisciplinary collaboration in the fields of nanotechnology, organic chemistry and clinical medicine. The workshop conducted a comprehensive review of metabolic research, identified topics that require long-term research, and narrowed down the research issues that should be resolved within approximately five years.

In terms of autonomous efforts at individual universities as well, on December 18, 2012 the "Disease Metabolomics Symposium" was held in the Kansai region. This symposium was sponsored jointly by the Osaka University Global COE Program "Frontier Biomedical Science Underlying Organelle Network Biology" and the Kobe University Global COE Program "Global Center of Excellence for Education and Research on Signal Transduction Medicine in the Coming Generation." It featured discussions aimed at linking metabolic research and clinical medicine research, through a comprehensive overview of metabolic research in terms of disease research as well as presentation of examples of applications to the disease research field. Moreover, in the area of applications for metabolic analysis that are designed especially for cancer research, the Japanese Cancer Association held the symposium "Cancer Metabolism 2013" from January 17 to 18, 2013. Discussions at the symposium emphasized the importance of metabolic research to cancer research in terms of drug discovery and the development of diagnostic techniques.

This Strategic Object will be prepared based on the results of these studies.

Other:

There are hopes that this Strategic Object will promote research that uses knowledge about disease-specific profiles of biomolecules and produces new concepts in drug discovery and treatment, as well as creating innovative techniques and medical applications through the incorporation of knowledge and technologies from other fields into drug discovery and healthcare development. New technologies of Japanese origin for drug discovery will be established through the involvement of researchers active in fields other than life sciences and researchers at private companies and so on, as well as by maintaining close communication with clinicians and drug developers.

5.2.2 Integrated clarification of the maintenance and change mechanisms of dynamic homeostasis in the body and creation of technology to understand and regulate complex dynamic homeostasis to achieve preventive medicine, appropriate diagnosis and treatment

Targets to Achieve:

For preventive medicine, appropriate diagnosis and treatment, technology that can be used to understand and regulate biological reactions caused by diseases must be created. This technology must be based on the homeostatic mechanisms within the body. Three goals must be achieved to help create such a technology.

- Clarification of biological homeostatic mechanisms and creation of control technology based on the understanding of functional networks among organs
- Understanding the dynamics of homeostatic mechanisms and creation of analytical technology based on the transition from growth to aging
- Creation of a technology to understand mechanisms of diseases (including lifestyle-related diseases) based on the understanding of breakdown of homeostatic mechanisms

Vision for Reaching Achievable Important Goals in Future:

The goal of this Strategic Object is to elucidate the mechanisms of maintenance and change in dynamic homeostasis as well as the mechanisms of aging and lifestyle-related diseases, through a single homeostatic mechanism in the body.

If the goals and objectives of this Strategic Object are realized, it will be possible to integrate traditional biological knowledge, methodology, and previously developed technologies for a comprehensive understanding of biological organisms. In other words, we will be able to elucidate the dynamics of total organism functionality, rather than understanding it as an amalgamation of unifunctional organs. It may also be possible to develop new pharmaceuticals, without side effects. This could also enable development of diagnostic and therapeutic methods based on holistic understanding of organisms, rather than symptomatic treatment. Furthermore, by elucidating temporal variations in homeostatic mechanisms, we may also be able to provide "ideal" medical care for individuals based on medical condition, age, and stage of life. This will lead to more precise assessments based on the evidence of medical effects within study populations, which may allow us to discover new problems from populations composed of healthy individuals and patients.

Realizing the research cycle made possible by these improvements to clinical research involves contributing to issues identified as being important to the achievement of life innovation goals set forth in the 4th Science and Technology Basic Plan. These issues are the development of revolutionary disease prevention methods, development of new early diagnostic methods, realization of safe and highly effective medical treatments, and improvements of quality of life (QOL) for the sick, elderly and disabled.

Specific Content:

Internal mechanisms trigger adaptive responses when an organism is exposed to various external stimuli and stresses. These mechanisms maintain the stability of the internal environment of the organism (homeostasis).

There has recently been an incredible accumulation of biological knowledge, remarkable advances in bioinformatics, and improvements in the functions of supercomputers. These remarkable developments are resulting in understanding of homeostatic mechanisms from research focused on individual organs. Research that can be used to elucidate this understanding is gradually becoming possible. In addition, the use of previous long-term cohort studies and animal models (e.g., knockout mice) is gradually allowing an understanding of the interaction between multiple organs in a single biological system. This in turn facilitates continued elucidation of how homeostasis is maintained within an organism.

This Strategic Object aims to elucidate a biological mechanism comprehensively as a single homeostatic mechanism linked by multi-organ functional networks. It also aims to elucidate the dynamic changes that occur in the homeostatic mechanism from early growth to advanced age. In addition, it aims to elucidate lifestyle-related and other diseases due to homeostatic mechanism dysfunctions and to understand pathophysiology by elucidating these dysfunctions.

Details are as shown below.

1. Systematic understanding of the multi-organ functional networks

We envision research that will elucidate the multi-organ functional networks including the nervous, immune, endocrine, circulatory, and other systems. We also envision research into the interactions between the various types of cells within a single organ. In traditional research focused on individual organs, study on interactions between various organs was not conducted systematically.

2. Understanding changes occurring in homeostatic mechanisms over time

Little research has been conducted on homeostatic mechanisms with regard to the chronological changes that take place during the lifespan of an individual. By quantitatively measuring homeostasis at the cellular level (which is considered to be unchanged once differentiation takes place), we aim to understand the condition and maintenance mechanisms of cells and organs at various stages of life. These stages include ontogeny, growth and development, biological maintenance, and aging. For example, we envision understanding the changes in the homeostatic mechanism that occur over the long period of aging as "transition points" for the metabolic networks and understanding the effects of changes in the homeostatic mechanisms of multiple organs.

3. Understanding the cause of disease as a breakdown of homeostatic mechanisms

Many diseases, including lifestyle-related diseases, can be understood as a dysfunction or breakdown of biological homeostatic mechanisms. Many diseases must be re-evaluated as affecting the entire organism from a homeostatic viewpoint. We envision research that uses the quantitative measurement of biomarkers, metabolic products, and other factors to elucidate the structure of biological defense mechanisms against pathogenesis and resulting changes.

Policy Positioning (positioning within the policy system and necessity/urgency in terms of policy etc.):

This Strategic Object has been cited in the New Growth Strategy (Cabinet Decision June 2010) and the 4th Science and Technology Basic Plan (Cabinet Decision August 2011) as contributing to policy issue solutions regarding the promotion of life innovation.

The New Growth Strategy approved by the Cabinet on June 18, 2010 stated that "as a major nation's health policy via life innovation" the Strategic Object would "promote the research and development of Japan's first innovative pharmaceutical, health care, and nursing care technologies with an exceedingly high degree of safety." This Strategic Object aims to elucidate the mechanisms of maintenance and change in biological dynamic homeostasis, realize the development of pharmaceuticals with no side effects through elucidation of the mechanisms of aging and lifestyle-related and other diseases and through the development of new treatments for diseases.

The 4th Science and Technology Basic Plan approved by the Cabinet on August 19, 2011 stated that as a method to "Ⅱ. Realization of Sustainable Growth and Societal Development into the Future 4. Promoting life innovation ⅲ) Realization of safe and highly effective medical treatment", the Strategic Object "will promote pharmaceutical innovation based on the classification and division of diseases into hierarchies, in order to improve the quality, safety, and effectiveness of treatment, and advance the development of methods of administration of pharmaceuticals that have few side effects based on the genetic susceptibilities of the population." To improve the quality of medical treatment, the Strategic Object aims to establish treatment methods appropriate to the various stages of life through elucidation of the dynamic changes that take place in the homeostatic mechanism at each stage of life.

In addition, the 2012 Important Science and Technology Policy Action Plan (July 21, 2011, Minister in Charge of Science and Technology Policy, Expert Diet Members of the Council for Science and Technology Policy) states that "new research and development of prevention, diagnosis, and treatment of lifestyle-related disease complications, such as those occurring in diabetes," is a priority initiative among the life-innovation items. This Strategic Object aims to contribute to the advancement of research and development of prevention, diagnosis, and treatment of lifestyle-related diseases such as diabetes through elucidation of diseases as a breakdown of homeostatic mechanisms and elucidation of the mechanisms of diseases.

Coordination with related policies, Division of Roles, and Differences in Policy Effects:

This Strategic Object aims to achieve a comprehensive understanding of homeostatic mechanisms at the biological level. This will be accomplished by utilizing measurement and analytical technologies developed during life science-related projects conducted by the Ministry of Education, Culture, Sports, Science and Technology, Japan. This Strategic Object will also utilize the results of research focused on individual organs and cells.

For example, this Strategic Object utilizes the technique of observing *in-vivo* kinetics of low-molecular weight compounds developed by the Strategic Research Program for Molecular Imaging conducted by the Ministry of Education, Culture, Sports, Science and Technology, Japan. This will make possible the investigation of problems in multi-organ networks of the endocrine system using low-molecular weight compounds. In addition, this Strategic Object will make possible the investigation of problems in multi-organ immune system networks and the relationship between the immune, nervous, endocrine, and circulatory systems by utilizing the results of research on the immune system. This includes the Core Research for Evolutional Science and Technology (CREST) project of the Japan Science and Technology Agency that includes "The Creation of Basic Medical Technologies to Clarify and Control the Mechanisms Underlying Chronic Inflammation" (established in the 2010 fiscal year).

The primary aim of the Japan Science and Technology Agency's CREST research area "Creation of Fundamental Technologies for Understanding and Control of Biosystem Dynamics" (established in the 2011 fiscal year) is analysis at the cellular and millisecond levels. Although this has targets different from the present Strategic Object, their research results may become useful to our research at a later stage. We thus hope to promote sharing of research results to promote research development.

Scientific Justification for the Research and Development Goals (need, urgency, achievability etc. based on domestic and international research trends):

Various countries have benefited from advances in measurement technology. In recent years, interdisciplinary grants and systems have been set up under the rubric of "complex system biology." The centers of research in this field are the Santa Fe Institute (Santa Fe, CA, USA) and the Institute Para Limes (Doesburg, the Netherlands). As a center of research for complex system biology in Asia, Nanyang Technological University in Singapore started complex system research program in August 2011. One example of a system focused on humans is the Complex Systems Grants, started in 2008 by US National Academies Keck Future Initiatives. This program measures various parameters of individual human organs and cells using the latest technology, and attempts to integrate the data.

In Japan, research is being conducted on communication between cells within organs as a way to study particular organs. Examples include research into the relationship between the cerebral nervous, circulatory, and endocrine systems. However, research that aims to form a comprehensive biological understanding of the communication between multiple organs is not being conducted.

The importance of a comprehensive understanding of biology has been discussed and debated in the scientific community. The academic symposium "Multi-organ Dynamics" (School of Science, University of Tokyo, Tokyo, Japan) held on October 8, 2011 received co-sponsorship from more than 20 scientific societies. The symposium included discussions regarding what was necessary to realize a comprehensive understanding of biology. The items discussed included technology, development of human resources, and adjustments to systems that promote research.

Thus, it can be seen that initiatives for the purpose of a comprehensive understanding of biology are underway, domestically and internationally. Japan should conduct research that will ensure its leadership in international competition, which involves urgently strategic promotion of domestic research.

Background to Deliberations:

In September 2008, the JST Center for Research and Development Strategy (CRDS) held a workshop entitled "An overview of life sciences and important research areas." One of the important research areas identified was the comprehensive study of the nervous, immune, and endocrine systems. CRDS presented a strategic proposal entitled "Homeodynamics," which was based on the Strategic Workshop on Homeostasis Research (January 2011) and others. This proposal identified the importance of comprehensive research aimed at the understanding and control of "homeodynamics" that maintains stability even as dynamic changes take place in accordance with the various stages of life.

The importance of a comprehensive understanding of biology has been discussed and debated in the scientific community. The academic symposium "Multi-organ Dynamics" (School of Science, University of Tokyo, Tokyo, Japan) held on October 8, 2011 received co-sponsorships from more than 20 scientific societies.

This Strategic Object is based on these discussions and debates.

Other:

The goal of this Strategic Object is creation of an interdisciplinary system that considers organisms as a single system and transcends the pre-existing studies in the nervous, immune, endocrine, and circulatory systems. In addition, we propose a comprehensive approach as a method to deal with the current fragmentation of clinical medicine into specialties. Therefore, we feel it is necessary that people from both academic and clinical fields conduct selection and assessment of research topics.

It is necessary to understand the importance of interdisciplinary studies and maintain them. To this end, the scientific community should simultaneously construct the research support system and re-evaluate medical education and research. It should also investigate new assessment methods to promote long-term development of human resources.

5.2.3 Creation of new technologies for breakthrough in understanding and predicting biological activities and intermolecular interactions by means of "Novel Structural Life Science" that contributes to new medical treatment and prevention of various diseases, food safety enhancement and environmental improvement

Targets to Achieve:

The goals listed below are to be achieved by research projects that integrate life sciences and advanced technology.

- Creation of new technologies for clarification of molecular-recognition mechanisms, molecular control, and design of new molecules. This will be achieved by understanding hierarchical change in spatiotemporal features caused by biomolecular interactions, modifications, and low-molecular weight compounds from the atomic to tissue levels
- Creation of elemental technologies of new structural analytical methods to clarify biomolecular interactions and functional expression mechanisms which control the essence of life phenomena for subsequent application
- Creation of new multidimensional study methods (Cross Correlation Method for Structure Analysis) that enable clarification of the dynamics of hierarchical structures and their control by seamlessly integrating various advanced elemental technologies of analysis

Vision for Reaching Achievable Important Goals in Future:

The goal of this Strategic Object is facilitation of innovation leading to societal benefits by developing "Novel Structural Life Science". "Novel Structural Life Science" is composed by integrating advanced life sciences and structural biology, and it enables temporal and spatial elucidation of the hierarchical structure from the atomic to cellular and tissue levels by seamlessly connected cutting-edge structure analysis methods. It derives universal principle to lead to estimate biological reactions and interactions from molecular structures. It is expected that this methodology will provide a solution for the important problems in life sciences.

Research outcomes listed in Section 'Targets to Achieve' are expected to lead to joint research with private companies to achieve the following goals. The goals and objectives are (i) elucidating a new control mechanism and developing new methods of treatment and diagnosis based on logical reasoning; (ii) developing new methods of inspection, prevention and treatment for food additives related to food safety inspection and bacteria and viruses related to food poisoning; and (iii) development of biofuels and other fuels as well as cultivation techniques that take into account environmental and other problems.

Achievements of these goals may lead to the (i) development of pharmaceuticals that have no side effects; (ii) development of new treatments for diseases; (iii) realization of individualized treatments in accordance with the patient's age; and (iv) techniques of growing plants that take into account environmental and other problems. The goal is to make a contribution to the issues that have been identified as being important to the realization of life innovation and green innovation goals set forth in the 4th Science and Technology Basic Plan. These issues are development of revolutionary disease prevention methods, development of new early diagnosis methods, realization of safe and highly effective medical treatments, improvement of Quality of Life (QOL) of the sick, elderly and disabled for life innovation, and realization of a stable energy supply and lower-carbon energy source usage for green innovation.

Specific Content:

- This Strategic Object elucidates molecular-recognition mechanisms through a hierarchical understanding from atomic level to tissue level of the interaction among proteins, nucleic acids, lipids, and other biopolymers and ubiquitination, phosphorylation, methylation, lipid-modification and glycosylation, and the changes in temporal and spatial superstructures that occur due to trans-organc compounds. In other words, It systematically analyzes the biomolecules having an important role in diseases and related molecular groups and elucidates their functions and structures as a network along a chronological axis. In addition, it contributes to future molecular control and design of new molecules through a combination of methods used in chemical biology and other disciplines.
- It develops technologies for elucidating life phenomena caused by dynamic intracellular and intercellular interactions among proteins, nucleic acids, lipids, and other biopolymers as well as changes in superstructures. It also develops new elemental technologies for elucidating molecular complexes, biopolymer modifications, and kinetic analyses using various types of position resolution, time resolution (dynamics), and states (from *in situ* to *in vivo*). Specifically, new methods and improvement of existing methods of crystal analyses using X-rays and neutrons, small-angle scattering- and nuclear magnetic resonance-based analyses, electron microscopy, mass spectrometry, and computational science are developed.
- Utilizing to the maximum extent the abovementioned elemental technologies, technologies of pharmaceutical development, and healthcare technology infrastructure and combining them in complementary and synergistic way, we will create new correlation structure analytical methods. This will enable understanding important biological phenomena as hierarchical structures from the atomic level to the cellular level, as well as help to elucidate their dynamics.
- When promoting the research mentioned above, we will create research teams comprising members from different fields. We will then conduct interdisciplinary research since it is necessary for researchers in advanced analytical fields and wide range of life science fields to collaborate.

Policy Positioning (positioning within the policy system and necessity/urgency in terms of policy etc.):

This Strategic Object has been cited in the New Growth Strategy (Cabinet Decision in June 2010) and the 4th Science and Technology Basic Plan (Cabinet Decision in August 2011) as making a contribution to policy issue solutions regarding the advancement of life innovation.

The New Growth Strategy, approved by the Cabinet on June 18, 2010, stated that as "health power strategy through life innovation", "we will promote research and development of highly safe, superior, and innovative pharmaceuticals and medical and nursing care technologies developed in Japan." The goal of this Strategic Object is to realize development of pharmaceuticals with no side effects and new treatment methods for diseases. This is performed through a hierarchical understanding from the atomic to the tissue level of interactions among biopolymers, modification, and the temporal and spatial changes in superstructures caused by trans-organic compounds and elucidation of the molecular-recognition mechanisms underlying all biological phenomena.

The 4th Science and Technology Basic Plan approved by the Cabinet on August 19, 2011 stated that as "Ⅱ. Realization of Sustainable Growth and Societal Development into the Future 4. Promoting life innovation ⅲ) Realization of safe and highly effective medical treatment," the Strategic Object "will promote pharmaceutical development based on stratification and classification of diseases in order to improve the quality, safety, and effectiveness of treatment, and will advance the development of administration methods of pharmaceuticals that have few side effects based on the genetic susceptibilities of the population." The goal of this Strategic Object is to develop pharmaceuticals with no side effects and facilitate the development of new treatment methods for diseases. This can be accomplished by applying multidimensional research methods to highly urgent targets that elucidate function of molecules concerning biological activities and temporally and spatially elucidate three-dimensional structures that are expected to contribute to future molecular control and molecular design.

In addition, the 2012 Important Science and Technology Policy Action Plan (July 21 , 2011, Minister in Charge of Science and Technology Policy, Expert Diet Members of the Council for Science and Technology Policy) mentioned "the acceleration of research and development currently under way, for example, early detection and the development of new treatment methods (pharmaceuticals, medical instruments, treatments, etc.), prevention and management of renal failure, diabetic complications, and myocardial infarction, and the control of depression, dementia, and other disorders. " The goal of this Strategic Object is to accelerate research and development, pharmaceutical development, and healthcare technology by utilizing the state-of-the-art research infrastructure in Japan and developing new elemental technologies that will contribute to the elucidation and application of biological phenomena (including molecular interactions).

This Strategic Object Object will also contribute to government policy issue solutions related to the promotion of green innovation. This was mentioned in the New Growth Strategy, the 4th Science and Technology Basic Plan, and the 2012 Important Science and Technology Policy Action Plan.

Coordination with related policies, Division of Roles, and Differences in Policy Effects:

- By proactively utilizing the support infrastructure for pharmaceutical and healthcare development, including the "Pharmaceutical Development Support Technology Infrastructure Platform Project," the control mechanisms for biological phenomena can be elucidated. This may also facilitate strong collaboration with industry as the "ripple effect" reaches them. In recent years, state-of-the-art research infrastructure that can be used in pharmaceutical development research, including micro-beam beamlines, has been used in synchrotron radiation facilities, and compound libraries containing approximately 200,000 compounds have been established. The potential for this infrastructure to elucidate a method to control biological functions and apply this to pharmaceutical research development is gaining the attention of academia, pharmaceutical companies, and other organizations. Using this government infrastructure, the Strategic Object will promote top-level, novel life science research in Japan.
- This Strategic Object focuses on the display of innate functions through dynamic interactions among proteins, nucleic acids, lipids, and other biopolymers. The goal is to elucidate, from the "bottom up," the biological phenomena and control mechanisms these innate functions contribute to through their detailed analysis at the atomic level. "Biodynamic system science" is used to understand various biological phenomena such as complete systems, rather than by their components. Also, using state-of-the-art measurement and calculation techniques and life-science technologies, biodynamic system science aims to understand and control complete systems through reconstruction of *in-vitro* cycles. The new knowledge regarding the mechanism of interaction between biopolymers gained from this Strategic Object will accelerate the elucidation of system mechanisms at the cellular level. Promoting both measures will make possible hierarchical understanding from the atomic to the organism level for the first time.
- The Exploratory Research for Advanced Technology (ERATO) project "Lipid Activity Structure Project" (started in the fiscal year 2010) aims to analyze the structure of lipids active in biological membranes and elucidate their functions. On the other hand, this Strategic Object intends to elucidate how proteins, nucleic acids, and carbohydrate chains interact from the atomic to tissue and cellular levels. Thus, we may achieve

synergistic results through cooperation with relevant ERATO projects.

Scientific Justification for the Research and Development Goals (need, urgency, achievability etc. based on domestic and international research trends):

In Japan, structural analysis of proteins is being conducted as part of the post-genome research effort. Information related to structural analysis of biopolymers including proteins is becoming increasingly important for the elucidation of complex mechanisms of biological functions. Seamless integration of protein structure and function understanding will become a driving force in the development of life sciences, and is expected to form a direct connection between pharmaceutical development and industrial applications.

Research and development of basic technologies related to this policy are being conducted worldwide.

The US National Institute of General Medical Sciences (NIGMS), one of the National Institutes of Health (NIH), established a research center specializing in analysis of membrane proteins in 2010. It introduced a partnership system for biological research made possible by high-throughput technology. Then, NIGMS conducts the Protein Structure Initiative Biology project, which places importance on biological impacts. In this project, structural science researchers work closely with biology researchers.

In addition to the USA, Sweden, the UK, and Canada have implemented the Structural Genomics Consortium project, which identifies and analyzes biomolecules important to human health *via* their three-country research network. They are engaged in pharmaceutical development that they hope will lead to the acquisition of international patents, which is why some of their data have not been published.

In Europe, challenging research has been at the forefront for several years. Some examples are the European Membrane Protein Consortium, which focuses on membrane proteins (started in 2005), the SPINE-2 Project, which is focused on compounds (started in 2006), and the European Pharmaceutical Initiative on Channels and Transporters (EDICT), which identifies channels and transporters in membrane proteins (started in 2008).

In China, next-generation life sciences are important national efforts. The third-generation large synchrotron at Shanghai Synchrotron Radiation Facility was completed in 2009, and is accelerating the pace of its research. Improvements in electron microscopy methods have also been noted.

As can be seen from the information given above, analytical research of biomolecules throughout the world is at a sufficiently high level and has a close relationship to applied research in life sciences, pharmaceuticals, and other fields. This suggests that we are heading toward the creation of a new paradigm. In Japan, the Target Protein Research Program (2007–2011) and other programs established international superiority by succeeding (ahead of Europe and the USA) in structural analysis of membrane proteins and very large protein complexes, which were previously difficult to analyze. Using these research results and research infrastructure, Japan must strategically promote research that takes advantage of this superiority on the premise that it will integrate the fields of advanced life sciences and structural biology.

Background to Deliberations:

The Science Council of Japan symposium “A Master Plan for the Future of Life Science” (19 May 2011) suggested research and development in system structural biology and other projects. Experts in life sciences made presentations and engaged in debates regarding major life-science projects at this symposium.

The workshop “Structural Biology Programs” (10 September 2011) was held at the JST CRDS. Next-generation life science research was debated, as well as other relevant topics. The specific topics of debate were the necessity of next-generation structural biology and the research themes that should be addressed.

At the Science Council of Japan symposium "Toward Progress in Structural Biology Focused on Fusion among Different Advanced Fields" (9 January 2012), the topic of next-generation life science research was debated.

This Strategic Object is based upon these discussions and debates.

Other:

Structural biology (and especially advanced analytical technologies) is advancing with remarkable speed and, as mentioned in section "Scientific Justification for the Research and Development Goals (need, urgency, achievability etc. based on domestic and international research trends)", international competition is becoming increasingly intense. When new elemental and other technologies are developed in the course of promoting this Strategic Object, it will be necessary to re-evaluate research plans and systems and adopt them in an appropriate and timely manner, and utilize these for the achievement of the goals of the Strategic Object.

5.2.4 **Creation of the basic technologies for disease analysis and elucidation of stem cell differentiation mechanisms by using epigenomic comparison toward the realization of treatments and regenerative medicine used to prevent, diagnose, and treat diseases**

Targets to Achieve:

○ Breakthroughs in identification techniques and understanding the mechanisms of epigenomic changes involved in cancer, diabetes, arterial sclerosis, etc. by means of animal—primarily human—epigenomic analysis.

○ Creation of the basic technologies required to differentiate and induce stem cells to its target organ cells by means of animal—primarily human—epigenomic analysis.

○ Development of the elemental technology for efficient epigenome mapping and analysis methodology, etc. using next-generation sequencers, etc.

Vision for Reaching Achievable Important Goals in Future:

This Strategic Object involves accumulating the basic knowledge required to develop the elemental technology for efficient epigenome mapping and analysis methodology, etc. using equipment such as the next-generation sequencers, to identify epigenomic changes involved in diseases such as cancer, diabetes, and arterial sclerosis, to elucidate their trigger mechanisms, to develop methodology that differentiates and induces cells and tissues that target stem cells, and to manufacture safe stem cells that can be adapted for use in regenerative medicine.

While developing and advancing medical technology/drug development for the aforementioned disease research being supported by the Ministry of Health, Labour and Welfare, and development of early diagnostic methods for cancer, etc. supported by METI, we intend to develop a database of epigenome information derived from research that can be used by a large number of researchers. Through this, we aim to identify the causative agents of epigenomic changes involved in disease, establish stem cell differentiation and induction methods, and develop the technology to manufacture safe stem cells.

By achieving the above-mentioned objectives, we aim to contribute to resolving the key issues for the realization of life science innovation goals associated with safe and effective regenerative treatments: "development of groundbreaking prevention methods," "development of new early diagnostic methods," and “realization of safe and effective treatments.” These will be the result of the development of revolutionary prevention/diagnosis methods and treatments utilizing disease epigenome information, the development of endogenous/exogenous cell proliferation and differentiation technology for iPS cells, and the development of utilization technology for such research and development related to safety evaluation technology.

Specific Content:

The genetic understanding of the origins of disease derived from human genome mapping represents a quantum leap forward.

Human genome information is shared among all cells, but the genetic expression at each cell varies with its condition after organ and cell differentiation, and this is controlled by epigenetics.

Especially in recent years, it has become recognized that epigenomic changes due to the influence of environmental factors among other factors play a large role in the onset of diseases.

Moreover, with regard to recent research into stem cell differentiation, it has been reported that the gene number required for induction efficiency or induction of iPS cells differ depending on the type of somatic cell, and that the tumorigenic transformation tendency of cells differentiated/induced form iPS cells depends on the type of derived cells, which suggests that epigenomic changes play a significant role in stem cell differentiation as well.

Thus, it is believed that the speed of research into disease prevention, diagnosis and treatment, and regenerative treatments using stem cells will be dramatically accelerated as a result of epigenome information analysis of disease cells in each diseased area and stem cell differentiation processes.

This Strategic Object involves the analysis of the epigenome information of diseased cells, and making breakthroughs in understanding what triggers epigenomic changes involved in the disease. At the same time, we aim to elucidate epigenomic changes related to stem cell differentiation processes, and by making breakthroughs in understanding the roles that stem cell differentiation plays, we intend to acquire the fundamental knowledge required to prevent, diagnose, and treat diseases, and utilize stem cells in regenerative medicine.

In particular, we envision the following types of research.

- By conducting comparative analysis of normal cells and disease-related cells, with human tissues and cultivated cell lines as primary subjects, and by enabling the evaluation of cell conditions interrelation and cells related to health maintenance/breakdown, we aim to conduct research that contributes to the prevention, diagnosis, and treatment of such diseases as cancer, diabetes, and arterial sclerosis.
- By means of the analysis/comparison of epigenome information from stem cell differentiation processes, and by breakthroughs in understanding the details of stem differentiation conditions—an area in which breakthroughs are yet to be made—we aim to conduct research that contributes to the evaluation of iPS cells and to regenerative medicine that utilizes iPS and other types of stem cells.
- With regard to the development of efficient epigenome mapping methods, given the rapid progress internationally, and taking into account the analytical methods that comply with international standards, we will give feedbacks on the research results of researchers who have actually performed epigenomic analysis, and develop the efficient mapping/analysis methods for elemental technology that leverages the most advanced device functions. In particular, we focus on the development of groundbreaking epigenomic analysis methods that utilize third-generation sequencers which enable faster and more accurate analysis than was previously possible, as well as cell preparation technology and antibody generation technology.

Furthermore, with regard to the project by the International Human Epigenome Consortium to map the human epigenomes of 1000 types of normal cells over the next 7–10 years, we will participate in the research in order to make advances based on this Strategic Object.

Policy Positioning (positioning within the policy system and necessity/urgency in terms of policy etc.):

The report issued by the Council for Science and Technology Policy in December 2010 regarding "Basic Policy for Science and Technology" deals with "the realization of safe and highly effective treatments," and clearly states that "it is necessary to make breakthroughs in disease and treatment mechanisms that take full advantage of diseased cells caused by iPS cells, and to search for new drug development targets. For this we must enhance and reinforce fundamental biological research." In addition, with regard to of the Life Science Committee meetings, Research Planning, Evaluation Subcommittee, Council for Science and Technology that were conducted for 3 months last year from June to August, the committee pointed out the necessity and urgency of epigenome research, and held discussions regarding Japan's participation in the International Human Epigenome Consortium.

Coordination with related policies, Division of Roles, and Differences in Policy Effects:

METI is focusing on cancer and conducting "Fundamental Technology Development for Drug Discovery using Epigenetic Genome Modification Mechanisms." The Ministry of Health, Labour and Welfare is focusing on patients with intractable diseases and conducting "research projects on patients with intractable diseases."

With regard to the research that falls under this Strategic Object, by actively pursuing linkages and collaboration among ministry programs, we will enable the utilization of the information accumulated by each ministry's program, and effectively advance epigenome research by Japan as a whole.

Scientific Justification for the Research and Development Goals (need, urgency, achievability etc. based on domestic and international research trends):

Recent research has produced a family of chemical modification modalities, such as DNA methylation by various chemically modified enzymes, and histone acetylation that binds to DNA. It is now clear that those epigenetic marks play a significant role in specifically controlling gene expression in various cells, cell differentiation, and the birth and aging of individuals.

On the other hand, due to significant developments in sequencers, rapid and accurate analysis that was previously unavailable has made possible DNA methylation profile analysis.

For this reason, epigenome research adoption and investment are included in the roadmap of the U.S. National Institutes of Health (NIH).

With regard to Japan, the Japanese Society for Epigenetics was established in 2007 and is shaping the research community.

Based on the results of analyses in research papers in recent years, Japan is making contributions to research fields dealing with epigenetic abnormalities and the onset of cancer, and because there is a high potential of international research in this field, it is critical that Japan continues to maintain its leading-edge technology.

Other:

To advance the overall project, it is necessary to research effectively and efficiently by establishing linkages with pioneering areas of research (i.e., epigenetic control and biological functions) that are related to this Strategic Object.

5.2.5 Creation of the technology systems to have absolute control of cells and cell populations by reproducing cell kinetics in silico/in vitro in order to achieve an integrated understanding of life phenomena and realize safe and highly effective treatments among other benefits

Targets to Achieve:

○ Develop models to reproduce/predict cell kinetics by the utilization of quantified data obtained and quantification basic technologies through visualization and measurement of diverse vital phenomena that occur within cells in order to advance the understanding of life functions (cell and cell population functions)

○ Develop the basic technologies to enable in vitro formation and reconstitution of structures such as protein synthesis, DNA synthesis, and biomembranes.

○ Develop the basic technologies to reproduce and manipulate cells and cell populations based on modeling and simulations derived in silico (by computer).

○ Develop the technology to predict and manipulate cell kinetic on the basis of a systematic understanding of dynamic changes in interactions of protein, DNA, etc. within cells.

Vision for Reaching Achievable Important Goals in Future:

By obtaining the results of the research falling under this Strategic Object as listed in Section "Targets to Achieve" above, we aim to achieve the following.

・ Reproduce phenomena controlled by a combination of factors such as cell aging that is the cause of various diseases and cell differentiation that is important for regenerative medicine.

・ Reproduce the reciprocal actions of specific biomolecules in cell population and intracellular microenvironments in order to advance the understanding of functions associated with various diseases such as cancer.

Achieve the realization of simulations of intracellular communication that is predictive of the practicability of drug discoveries, etc.

By applying these research results to disease research supported by the Ministry of Health, Labour and Welfare as well as healthcare and drug discovery research conducted by industries and other circles, we aim to establish simulation technology for complex and dynamic life phenomena that can be used for drug discovery and breakthroughs in disease onset mechanisms for diseases, such as cancer and adult lifestyle disease triggered by complex factors.

By achieving these goals, we aim to contribute to the development of groundbreaking drug discoveries in anti-cancer drugs, etc. as well as new disease treatment methods derived from autoimmunity control, the discovery of effective and efficient drugs with few side effects by utilizing simulations, and critical issues for the achievement of life innovation objectives such as "development of revolutionary prevention methods," "development of new early diagnosis methods," "actualization of safe and highly effective treatments," and "quality of life (QOL) improvements of the sick, the elderly, and the handicapped."

Specific Content:

To achieve an essential understanding of the complex changes in life phenomena, the following cycle has proved effective: "quantitative measurement of temporal and spatial data," "the construction of numerical models based on actual measurement data (in silico reproduction of cell kinetics)," "reconstruction based on numerical models (in vitro reproduction of cell kinetics)," and recent advancements in the life science, measurement science and computational science is making this process possible.

This Strategic Object involves creation of technology for the in silico reconstruction of cell and cell population dynamics, and in vitro reproduction based on the predictions and designs derived thereof.

In particular, with respect to the current state of research in the fields of cell measurement, cell simulations, synthetic biology, etc., the following types of research are envisioned.

(1) Development of technology for quantitative measurement of complex multifactors (molecules or cells) as well as the technology to analyze and model that multifactor data, and the integrated development of technology to reconstruct cell phenomena in vitro.

(2) Research that will contribute to the understanding and control of dynamic life phenomena, through application of the 3-step cycle: measurement, modeling, reconstruction.

(3) Research that will contribute to the integrated understanding of life phenomena that occurs between the stages such as organ: tissue, cell and molecule.

(4) Development of visualization and numerical modeling modalities integrated with measurement, mathematical analysis, and measured data required for processing the enormous quantities of cell measurement data.

(5) With regard to complex life phenomenon—such as a complex organ formation, the multiplicity of anti-cancer drug effects and side effects, and adult lifestyle diseases caused by combined factors—that could not be controlled with traditional approaches, the research aims to create new biomedicine with superior forecasting and control capabilities through the advancement of these issues.

Policy Positioning (positioning within the policy system and necessity/urgency in terms of policy etc.):

For this Strategic Object, in terms of a strategy to forge a science/technology information-communication nation as part of the New Growth Strategy (approved by the Cabinet in June 2010), and with regard to the dynamic life systems science for upgrading the basis for new technology development and opening up new field, the report on "basic policies for science and technology" (December 2010, Council for Science and Technology Policy, Cabinet Office) declared the necessity of advancing scientific research into dynamic life systems.

In addition, the Science Council of Japan held a symposium in May last year entitled "Dynamic Life Systems Science Symposium," at which research areas were defined and discussions were held on important strategic issues that must be advanced as well as the need for proactive action on the part of the academic/research community as summarized in their "action plan recommendations toward advancing dynamic life systems science." The Life Science Committee, Research Planning, Evaluation Subcommittee, Council for Science and Technology published a report entitled "Constructing and Developing New Life Science Research—Life Science Research Basic Direction for the Fourth Term Science and Technology Basic Plan" (December 2009). In this report, new currents in life science research and key research issues in dynamic life science research were described. Also, the Life Science Committee Meeting held in June last year discussed measures and policies concerning the advancement of dynamic life systems science research.

Dynamic life science systems research creates new developments in technology and opens up new fields. Accordingly, because of its great importance as the basis of the life sciences, its potential to raise Japan's competitiveness is great. Furthermore, based on trends in research overseas (See Section "Scientific Justification for the Research and Development Goals (need, urgency, achievability etc. based on domestic and international research trends):"), it is essential that domestic research into dynamic life science systems be advanced strategically as soon as possible so that Japan does not lag behind in terms of international competitiveness

Coordination with related policies, Division of Roles, and Differences in Policy Effects:

As an auxiliary subject for Leading-edge Research Infrastructure Program, the advancement of dynamic biological systems research was adopted. Furthermore, Osaka University and RIKEN are collaborating to develop the base infrastructure to carry out elemental technology development—the basis of cell research—that is centered on intracellular molecular dynamics.

In addition, funds for "life systems research projects" have been allocated in RIKEN's 2011 budget, and along with the implementation of the core programs in the above-mentioned projects, each university, research center, industry, etc. are forming "collaborative programs" with a focus on creating systematized techniques for technology that is key to regenerative medicine; for example, technology to form solid tissues from stem cells. The research can be effectively advanced as these research bases and collaborative programs share their successful results and form appropriate linkages.

The subject of this Strategic Object is research and development in fields not limited to regenerative medicine, with the goal of advancing the formation of research and research communities based on fresh ideas from young researchers that are needed in dynamic life systems science, which is an area of multidisciplinary research. By these means, we will foster not only the researchers who have been engaged in life sciences until now, but also multi-specialty personnel who are conversant in measurement, mathematics, and computation.

Scientific Justification for the Research and Development Goals (need, urgency, achievability etc. based on domestic and international research trends):

In the U.S., the National Science Foundation and institutions such as Stanford University are forming and reinforcing multidisciplinary bases combining life science research and mathematical analysis. In Germany, the University of Heidelberg and EMBL (European Molecular Biology Laboratory) etc. have developed similar dynamic life system science research bases, showing that new research trends are emerging in this research field. On the other hand, while Japan is by no means exerting its maximum effort in the field of dynamic life systems science, Japan's cell measurement technology, which is the elemental technology for this type of research, and its experimental technology (intracellular protein measurement) as well as its equipment development (microscopes, etc.) are the world's best. Japan also leads the world in the field of applied physics, such as in the development of lasers required to perform measurements within living cells. Japan, which has the bases for advancing multi-disciplinary research development that synthesizes successful results of basic research, must consolidate its fledgling and trailblazing research results, while utilizing its base of core technology development facilities; it must make strategic investments in this research, keeping an eye on possible industrial applications, because there will never be a better time for Japan to establish international leadership in this field.

As reported in the publication "Life Science Fields: International Comparison of Science and Technology/Research and Development" (February 2010, JST Center for Research and Development Strategy), Japan's research and technology development for research into structure biology related to dynamic life system science, imaging technology, and structural life science is at a high level. The paper noted the importance of collaborations between experimental life science and information methodology for generation and regeneration field, and in the field of immunology the importance of technology innovations that will permit a single lymphocyte to be tracked within an organism, all of which suggests that progress in the field of dynamic life systems science will contribute to innovations in a variety of life science fields. In addition, with regard to system biology that combines various fields such as life science, physics, and engineering, it was noted that "although in terms of each research's level, it can be favorably compared to that of the U.S., there is still a single-digit disparity in the population of researchers, and it is believed that this gap will continue to widen" and the importance of making progress at the present stage was mentioned.

Other:

These types of cooperative and integrated research projects demand free and uninhibited generation of ideas and the creation of environments that will generate collaborative work, as well as strict progress management to accomplish the difficult task of achieving the objectives. Also required is the formation of research systems that promote research based on the groundbreaking ideas of young researchers and community formation. Moreover, with regard to the human resources that will support this field of research in the future, it will be necessary to examine how to create a system that provides more opportunities than were previously available, for actual experience in consolidating knowledge of interdisciplinary research, and experience in managing research fields.

Furthermore, linkages and collaborations must be formed with multidisciplinary research fields (optical/quantum physics technology, mathematics-related) related to this Strategic Object, and it will be necessary to make progress in research effectively and efficiently in terms of the overarching project.

5.3 Information and Communication Technology

5.3.1 Creation, advancement, and systematization of innovative information technologies and their underlying mathematical methodologies for obtaining new knowledge and insight from use of big data across different fields

Targets to Achieve:

This program, by carrying out research in collaboration between the information science/mathematical science fields and various research fields (application fields) that are having a major impact on society by utilization of big data, aims to create and advance next-generation application technologies that, by solving issues in the application fields, can obtain new knowledge and insight from big data; and it further aims to build common core technologies enabling integrated analysis of big data from a variety of fields. To these ends the program aims to achieve the following targets.

○ Creation and advancement of next-generation core application technology that, while promoting use of big data in individual application fields, assumes expansion to a variety of fields
○ Creation, advancement, and systematization of next-generation core technology for integrated analysis of big data from a variety of fields

Vision for Reaching Achievable Important Goals in the Future:

By achieving the research results stated in the Section "Targets to Achieve" for this Strategic Object, it is possible to construct common core technologies for integrated analysis of big data from a variety of fields and realizes the use of big data across fields. Using the constructed technology would enable the high-degree application of academic paper data in research fields where use of big data is effective, experimental/simulation data, and observation data; this in turn would enable acceleration of generation of innovation in integrated fields combining multiple different areas, including social sciences and humanities.

Following completion of this project, the aim is to realize the following, for example, through the promotion of research and development and practical application using common core technologies enabling integrated analysis of big data in various fields by academia and industry.

- In the field of life science, establish order-made medical care, early diagnosis, and effective treatment methods using efficient techniques for seeking disease-associated genes utilizing whole-genome data for 100,000 people (3 billion base pairs) linked to treatment information.
- In the global environment field, establish basic information technology that connects the relationships between different data—such as global warming; natural environment issues such as forest and water cycles, ecosystems, and geographical space—at a high level in order to contribute to the resolution of global-scale issues in which various factors are complexly intertwined and create a sustainable society.
- In the field of disaster prevention, promote strengthening of exhaustive disaster prediction and disaster prevention functions as well as optimal planning methods for cities using technology that accumulates and structures meteorological data obtained from disasters and accidents as well as geospatial data in a form that can be easily analyzed.

The aim of this strategic object is to, by realizing the above, create new industries and markets through innovation and promote the strengthening of Japan's international competitiveness, as well as contribute to the achievement of "strengthening the industrial competitiveness of Japan" and "development of research information infrastructure" as prescribed in the 4th Science and Technology Basic Plan (approved by the Cabinet on August 19, 2011).

Specific Content:

With the progression of the advanced information society, we have arrived in the era of big data (information explosion) in which digital data is increasing explosively. According to statistics compiled by a private-sector survey institution, [*1] the amount of digital data worldwide is expected to grow to approximately 35 zettabytes in 2020 (approximately 35 times the amount in FY2010). Furthermore, according to a survey conducted by the Institute for Information and Communication Policy,[*2] the amount of data distributed in Japan in FY 2009 was 7.61E21 bits (equivalent to approximately 290 million DVDs per day) (for example, E18 bits indicates that a bit is 10 to the power of 18), but the amount of data consumed was 2.87E17 bits (equivalent to approximately 11,000 DVDs per day), and so it is said that the amount of information consumed is only 0.004% of the amount distributed.

While this qualitative and quantitative flood of data (big data) enables the acquisition of new knowledge and insight, when attempting to combine various data (a diversity of data ranging from natural science data such as bio and astronomical observations to social science data on human observations) and process it on a large scale, in many cases there is a large amount of unanticipated data and data that cannot be analyzed correctly, and so the current situation is that much of this data is not organized or structured and cannot be utilized effectively.

For this reason, there is growing international awareness of the importance of effectively and efficiently collecting and consolidating this data as well as discovering new knowledge and creating new value through innovative scientific methods. Alongside the first scientific method of empirical science (experiments), second scientific method of theoretical science, and third scientific method of computational science (simulations), data centric science (=e-science) is said to be the fourth scientific method,[*3] and is gaining attention as a method for opening up new scientific frontiers in the big data era.

This Strategic Object aims to realize two objectives to be achieved in order to conduct research and development of innovative methodologies for smoothly carrying out big data analysis. Specifically, the following research is being pursued.

(1) Creation and advancement of next-generation core application technology that, while promoting use of big data in individual application fields, anticipates expansion to a variety of fields

In addition to resolving issues in individual application fields, strengthening of the expansion of individual technologies into other fields and the introduction of new core elements are being promoted. For this reason, it is expected that systems of cooperative research teams comprising researchers in the fields of information science/mathematical sciences and application will be created. Specifically, the following research is being promoted.

- Research and development aimed at easy realization of the transfer, compression, and storage of a large amount of diverse data (health/medicine data, earth observation data, disaster prevention-related data, social data, etc.)
- Research and development aimed at extracting significant information by searching, comparing, and analyzing image data, three-dimensional data, and various other data
- Research and development aimed at more accurately discovering and gaining insight into new topics from application data (clarification of disease factors, forecasting climatic changes, disaster mitigation using real time analysis, forecasting people’s needs, etc.)
- Establishment of research and development infrastructure for promoting a heuristic search-style research approach that provides new knowledge or expertise by constructing a diversity of mathematical models related to living organisms and natural phenomena, etc., from quantitative data and combining this with actual measurement data.

(2) Creation, advancement, and systematization of next-generation core technology for integrated analysis of big data from a variety of fields

Development of new and original core elemental technologies and of new elemental technologies that spread across multiple application fields by researchers in the fields of information science, mathematical sciences, and humanities is carried out. Specifically, the following research is being pursued.

- Data cleansing technology (noise removal, data normalization, absorption of unnecessary data changes, etc.) and technology that automatically creates annotations of meaning or content of data
- Advanced compression technology, technology enabling searches to be made for data while still compressed, technology enabling data mining without losing confidentiality or anonymity
- Upgrading of data mining technology and machine learning (technology for modeling from large amounts of diverse data, technology for searching for relationships between different types of data)
- Visualization technology for gaining insights from the correlations and relationships between various application data
- System technology for sharing and distributing big data (data processing, metadata management, traceability, creating anonymity, charging, security, etc.)
- Mathematical and computational methods for discovering the essence of issues and structure of big data

In addition, in (1) creating and advancing next-generation core application technology, it is effective to proceed while also incorporating next-generation core technology obtained through the research conducted in (2); moreover, in (2) creating, advancing, and systematizing next-generation core technology, it is effective to proceed while also sharing and utilizing next-generation application technology obtained through the research conducted in (1). For this reason, the research conducted in (1) and (2) needs to be mutually coordinated.

*1 IDC, “Big Data, Bigger Digital Shadows, and Biggest Growth in the Far East”, December 2012

*2 Institute for Information and Communication Policy Survey Division, “Results of Survey Research on the State of Japan’s Information and Telecommunications Market and Measurement of Information Distribution Amounts (FY2009): Measurement of Information Indexes”, August 2011

*3 Tony Hey, Stewart Tansley, and Kristin Tolle. *The Fourth Paradigm: Data-intensive Scientific Discovery* (Microsoft Research 2009)

Policy Positioning (positioning within the policy system and necessity/urgency in terms of policy etc.)

Under the section “Responses to Essential Issues Facing Japan” in the 4th Science and Technology Basic Plan, promoting research and development of innovative common core technologies such as core technologies for supporting the utilization and application of electronic devices and information-telecommunications, as well as promoting strategies for appropriately opening up these technologies are given as means of “strengthening the industrial competitiveness of Japan”. Furthermore, promoting research and development related to advanced information and communication technologies such as simulation and e-science, science and technology that can be applied across multiple fields such as mathematical science, and science and technology for integrated fields is given as a means of “improvement and reinforcement of common infrastructure for Science and Technology”. In addition, under the section “Enhancement of Basic Research and Human Resource Development”, constructing and expanding “knowledge infrastructure” systems that enable integrated searching of and data extraction from all research information in order to promote efforts to strengthen research information infrastructure is given as a means of “development of research information infrastructure”.

In order to promote the necessary discussion and consideration of “academic clouds”, which enable researchers at universities and other institutions nationwide to easily access online and utilize data, information, and research materials from many fields that can be applied to scientific research and use the latest “data science” methods to obtain scientifically or socially significant research results, the Ministry of Education, Culture, Sports, Science and Technology established the “Conference for Reviewing Academic Clouds” under the Director-General of the Research Promotion Bureau. From April through June 2012, three topics for consideration were discussed—“Coordination of databases”, “Construction of system environments”, and “Research and development contributing to the enhancement of data science”; proposed in July, the “Challenges for Academia in the Era of Big Data” summarized the direction that research and development of core technologies is important at each stage of big data processing (data collection, accumulation/structuring, analysis/processing, and visualization) as research and development of common core technologies related to big data.

Coordination with Related Policies, Division of Roles, and Differences in Policy Effects

In October 2012, the Minister of State for Science and Technology Policy and executive members of the Council for Science and Technology Policy selected “FY2013 Science and Technology Budget Priority Policy Packages” and the “Improvement of infrastructure aimed at generating new industries and innovation using big data” proposal made jointly by three ministries—the Ministry of Internal Affairs and Communications; Ministry of Education, Culture, Sports, Science and Technology; and Ministry of Economy, Trade and Industry—was identified as a priority policy package that should be prioritized for resource allocation. Under this priority policy package, the three ministries will collaborate to promote in an integrated manner human resources training as well as research and development of core technologies related to the collection, transfer, processing, usage/application, and analysis of big data in certain fields aimed at realizing these technologies by around 2016.

Of these three ministries, the Ministry of Education, Culture, Sports, Science and Technology has positioned one of its Research and Development for Next-generation Information Technology programs, "Research on Systems for Utilizing and Applying Big Data" as an individual priority within the priority policy package. In addition to promoting human resources training of data scientists and other specialists through international cooperation using research centers integrating different scientific fields, this program conducts investigations of issues concerning the development of technologies such as data-related technologies and the ways academic cloud environments (environments for coordinating and sharing cloud bases between universities) are constructed. Furthermore, in order to construct models for utilizing big data, the Japan Science and Technology Agency is endeavoring to dig up enormous amounts of data that is lying idle and improving rules in order to promote database coordination amongst research organizations and usage of databases by the privates sector, etc. In addition to the above policies, research and development aimed at the advancement and systemization of common core technologies aimed towards the resolution of next-generation issues from a medium- to long-term perspective is undertaken under this Strategic Object to enable the usage and application of big data across fields.

Furthermore, in May 2012, the ICT Basic Strategy Board of Information and Communications Council, Ministry of Internal Affairs and Communications, summarized "Usage of Big Data", remarking that, since construction of information/communication infrastructure is underway, this infrastructure test bed (JGN-X) constructed and operated by the National Institute of Information and Communications Technology (NICT), may also be used as necessary when promoting research in this Strategic Object.

Scientific Justification for the Research and Development Goals (need, urgency, achievability etc. based on domestic and international research trends)

In the United States, the President's Committee of Advisors on Science and Technology (PCAST) determined in 2011 that the Federal Government's investment in big data technology was insufficient, and in response, the Office of Science and Technology Policy (OSTP) announced a Big Data Research and Development Initiative on March 29, 2012. This initiative aims to improve and strengthen technology for accessing and organizing data and gleaning discoveries through a total investment of 200 million US dollars by 6 Federal departments and agencies (NSF, NIH, DOD, DARPA, DOE, and USGS). In Europe and Asia, too, investment is being made in big data research, and intense international competition is expected in the future. Specifically, in Europe public expenditure for ICT research and development is being doubled from 5.5 billion euros to 11 billion euros by 2020 and large-scale pilot projects are being carried out as part of endeavors to develop innovative and interoperable solutions in fields that are of public interest (ICT for conserving energy and resources, sustainable healthcare, electronic government, and intelligent transportation systems, etc.). Furthermore, in China centers have been established for sharing information resources, and technology is being developed for creating metadata and automatic classification in order to establish mutual relationships between collected data. In addition, South Korea is to commence construction in 2013 of a National Scientific Data Center for promoting sharing of research data, including big data, and data science. Consequently, there is an urgent need for research and development advancing the use and application of big data across fields with the aim of promoting innovation in the science and technology field through collaboration that transcends the division of roles between the public and private sectors as well as ministerial and agency frameworks.

In Japan, various types of sensor information are evolving and there are related research fields where the standard of research is world-class, such as high-performance computing and natural language processing; efforts are also being undertaken in fields that handle large-scale data requiring research in regional units, such as genetic information. For these reasons, expanding these strengths into a broad range of fields and areas when utilizing large-scale data creates an environment in which common core technologies in science and technology as well as industrial competitiveness can be strengthened.

Background to Deliberations:

The "Conference for Reviewing Academic Clouds" established under the Director-General of the Research Promotion Bureau of the Ministry of Education, Culture, Sports, Science and Technology summarized the "Challenges for Academia in the Era of Big Data", proposed on July 4, 2012, as well as specific research and development items and the direction that research and development of core technologies is necessary at each stage of big data processing (data collection, accumulation/structuring, analysis/processing, and visualization) for research and development of common core technologies related to big data.

Based on this, the Committee on Information Science and Technology, operated under the Subdivision on R&D Planning and Evaluation, Council for Science and Technology (77^{th} and 78^{th} sessions) (July 5 and August 2, 2012) also expressed the opinion that research and development of common core technologies for utilizing and applying big data is necessary based on shared awareness of the importance of "data science" that creates new intellectual value through the efficient and effective gathering and accumulation of large quantities of data generated as the results of intellectual activity in various fields and processing of information using innovative scientific methods.

Furthermore, the "Mathematical Innovation Strategies (Interim Report)", which was compiled by the Advanced Research Base Working Group of the Council for Science and Technology (5th session) (August 7, 2012), states that, in order to develop innovative methods and technologies for effectively utilizing big data, it is important that not only do mathematical researchers proactively collaborate with researchers in information science fields and various areas of application but also that the diverse knowledge and potential of mathematical researchers themselves is fully utilized and efforts are made to create common core technologies for identifying essence and structure for efficiently utilizing big data.

This Strategic Object was formulated based on consideration of the above factors.

Other:

In promoting this Strategic Object, it is expected that the creation of flexible networks for researchers in big data-related fields and the construction of new human resource training schemes and innovation-generating cycles (environments in which innovation is constantly being created) will also be pursued through the fusion of information/mathematical science fields and various research fields in which big data is effectively utilized.

Chapter 6 Key Points in Submitting Proposals

○ Violation of the guidelines provided in this chapter or any other inappropriate behavior may result in withdrawal of approval for the research project or cancellation of the research; return of all or part of the project's research funding, and measures taken to publicize the facts of the matter.

○ Violation of related laws or guidelines, etc., in conducting research may result in cancellation of your research funding allocation or withdrawal of the research funding allocation decision.

6.1 Handling of Information Provided in Research Proposals, Etc.

○ From the standpoint of maintaining the interests of the applicant, the "Act on the Protection of Personal Information Held by Independent Administrative Agencies, etc.", and other standpoints, research proposals shall not be used for any purpose other than the selection process. Confidential information regarding research proposal details shall be strictly maintained. For details, please refer to the following website.

http://law.e-gov.go.jp/htmldata/H15/H15HO059.html

○ Handling of Information Regarding Selected Projects

Information regarding individual projects that have been selected (name of system, name of research project, name of affiliated research institution, name of Research Director, budget amount, implementation period, etc.) shall be deemed to be "information that is scheduled to be made public" as prescribed under Article 5, Paragraph 1, Item (a) of the "Act on Access to Information Held by Independent Administrative Agencies" (Act No. 140 of 2001).

The name of the researcher, name of the affiliated research institution, name of the research project, and the research project overview summary are scheduled to be made public. In addition, the research proposals of selected applicants may be used by the JST to promote the research after the proposal's approval.

○ Provision of Information from the Cross-ministerial R&D Management System (e-Rad) to the Government Research and Development Database

Various information may be provided to the Government Research and Development Database*[1] being developed by the Cabinet Office through the Cross-ministerial R&D Management System (e-Rad), which is managed and operated by the Ministry of Education, Culture, Sports, Science and Technology.

Furthermore, you may be required to provide cooperation with regard to various work tasks and checking in order to prepare this information. Please see the following portal site for the Cross-ministerial R&D Management System (e-Rad).

http://www.e-rad.go.jp/

6.2 Unreasonable Duplication and Excessive Concentration

○ In order to eliminate unreasonable duplication and excessive concentration, to the extent necessary

*1 To enable appropriate evaluation of R&D conducted with national government funding, and effective and efficient formulation of plans for policies for comprehensive strategies and resource allocation, the Cabinet Office Council for Science and Technology Policy is constructing a database that enables integrated and exhaustive understanding of various types of information and searches for and analysis of the required information.

information regarding some proposals (or selected projects/programs) may in some cases be provided through the Cross-ministerial R&D Management System (e-Rad) to other departments in charge of competitive funds, including other government ministries. (Furthermore, when it is required that checks be made for duplicate project applications under other funding programs, information may be provided in a like manner.)

【Measures against Unreasonable Duplication and Excessive Concentration】

(a) Measures against "Unreasonable Duplication"

In the case that a researcher is unnecessarily receiving competitive funding from multiple sources for the same research project (name or content of research receiving competitive funding; hereinafter the same shall apply) being undertaken by the same researcher and any of the following applies, the researcher shall be made ineligible to apply for this program, selection of their research project withdrawn, or their research funding reduced (hereinafter referred to as "withdrawal of research project selection").

1) In the case that simultaneous proposals have been submitted for multiple competitive research funds and duplicate approval granted for essentially the same research project (including cases in which there is a considerable degree of research content duplication; hereinafter the same shall apply).

2) In the case that a duplicate application is made for funding of a research project that is essentially the same as another research project that has already been selected and has already received competitive research funding.

3) In the case that there is overlap in the intended application of research funding between multiple research projects.

4) Other cases equivalent to the above

Although at the application stage for this program there are no limitations regarding the submission of proposals to other competitive funding programs, etc., in the case that a research project is selected by another competitive funding program, please report this promptly to the JST at the contact address given at the end of this document. If reporting is omitted, the approval decision for the research project may be revoked.

(b) Measures against "Excessive Concentration"

Even if the content of the research proposed for this program differs from the content of research being carried out under another competitive funding program, in the case that the overall research funding allocated to the same researcher or research group (hereinafter referred to as "researchers") in the relevant fiscal year exceeds an amount that can be utilized effectively and efficiently and cannot be used within the research period, and any of the following applies, selection of the research project under this program may be withdrawn.

1) In the case that an excessive amount of research funding is being received in light of the capabilities of the researchers and the research methods being used, etc.

2) In the case that an excessive amount of research funding is being received in comparison with the amount of effort (percentage of the researchers' overall working time that is required for carrying out the said research project) being allocated to the research project.

3) In the case that highly expensive research equipment is purchased unnecessarily.

4) Other cases equivalent to the above

For this reason, in the case that you submit proposals to other competitive funding programs, after submitting your application for this program, and the research project is selected by another competitive funding program, or if any information provided on your application changes, please report this promptly to the JST at the contact address given at the end of this document. If reporting is omitted, the approval decision for the research project may be revoked.

(From the "Guidelines for the Appropriate Implementation of Competitive Research Funding" (revised March 27, 2009 by mutual agreement of the Liaison Conference among Relevant Ministries and Agencies on Competitive Funding)

○ Please note that researchers who are selected for and are conducting research and development under the "Funding Program for Next Generation World-Leading Researchers (NEXT Program)" may not receive research funding (excluding funding for programs not directly aimed at research and development) from the national government or independent administrative agencies from FY2011 until the end of the project period.

○ In the case that the researcher is receiving Grants-in-Aid for Scientific Research or other competitive research funding operated by the national government or independent administrative agencies, or other research grants (including funding for which applications have been submitted), please provide information about this funding on the research proposal in accordance with the prescribed format (CREST: Form 10; PRESTO: Form 5).

Based on information regarding the content of the research proposal and effort (research time allocation rate),*[1] in the case that either unreasonable duplication or excessive concentration of competitive funding has occurred, the research proposal may not be selected or selection may be withdrawn, or research funding may be reduced. Furthermore, the research proposal may also not be selected or selection may be withdrawn, or research funding may also be reduced in the case that the information provided on the research proposal is found to be false.

○ In order to eliminate the unreasonable duplication or excessive concentration of competitive funding mentioned above, in the case that a researcher is receiving other competitive funding operated by the national government or independent administrative agencies or other research grants, or in the case that a researcher has been selected for such funding, the researcher may not submit proposals for this program for research with the same project name or content.

○ In the case that the applicant is scheduled to receive 100 million yen or more in research funding under other systems or research grants, etc. in FY2013 or 2014, in view of the purpose of eliminating unreasonable duplication and excessive concentration, as a general rule final selection of the research project and budget amounts are decided in an integrated manner. In the case that the applicant is scheduled to receive a total of 100 million yen or more from multiple funding systems/grants, he/she is given individual consideration accordingly within the selection process.

Although not relevant for research projects at the application stage, the research proposal may be removed from the selection process for this program or the selection decision withdrawn depending on the outcome of selection for other competitive funding or research grants. Furthermore, when it is discovered,

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*1 This is based on the Council for Science and Technology Policy's definition of 'effort', which is "the percentage of working hours required for conducting the relevant research when the researcher's total annual working hours are 100%". Note that "total working hours" does not refer only to the number of hours spent in research activities but to the substantive total working hours, including educational and medical activities.

during the selection process for this program, that the research project has been approved/rejected for another competitive funding system, please report this promptly to the JST at the contact address given at the end of this document.

6.3 Measures against Inappropriate Usage of Research Funds

○ In the case that research funds intended for use under this program are used for other purposes, the conditions stipulated by the JST for payment of research funds are violated, research funds are received through fraudulent means, or research funds are otherwise used in a manner that runs counter to the objectives of the program, the research project in question may be cancelled; all or part of the project's research funding returned, and measures taken to publicize the facts of the matter. Furthermore, limitations shall be placed for a certain period of time on application to or participation in this program for different projects by researchers found to have used research funds inappropriately (including coconspirator researchers).

○ Limitations shall be placed for a certain period of time on eligibility for application to or participation in this program for researchers who have received funding under other competitive research funding systems operated by the national government or independent administrative agencies*[1] or programs other than competitive funding programs that are under the jurisdiction of the JST and have used these research funds inappropriately and to whom limitations on application/participation eligibility for the relevant program have been applied.

(Limitations shall also be placed on participation for the fiscal year in which the inappropriate usage of research funds is deemed to have occurred. Moreover, limitations may be applied retroactively.)

○ In the case that research funds under this program are used inappropriately, information regarding the details of the inappropriate usage by the researcher in question and their coconspirator researchers is provided to those in charge of other competitive funding programs (including independent administration agencies). Consequently, limitations may be placed on application to or participation in other competitive funding programs.

Limitations shall be placed on the period of application and participation in this program on researchers who have used research funds inappropriately and their coconspirator researchers in accordance with the degree of inappropriateness. The period of the limitations shall as a general rule be between one and ten years from the fiscal year following the year in which the contract funds related to the inappropriate usage of funds are reimbursed. "Application and participation" refers to the submission of proposals, applications, and requests for new research projects by the researcher or participation in new research by the researcher as a joint researcher.

Details of Research Funding Usage	Period Deemed Appropriate

*1 For specific information regarding other funding programs, please refer to the following website.
http://www.jst.go.jp/bosyu/notes.html
These measures also apply to programs that began calling for applications in FY2012. Please note that the above measures and the list of funding programs are subject to change, so please check information on the relevant Ministry of Education, Culture, Sports, Science and Technology website or JST website.

1. Cases in which the extent of the inappropriate use of research funds, etc. is deemed to have had minimal effect on society and the maliciousness of the action is deemed to be low.	1 year
2. Cases in which the extent of the inappropriate use of research funds, etc. is deemed to have had a large effect on society and the maliciousness of the action is deemed to be high.	5 years
3. Cases apart from 1 and 2 in which the impact of the action on society and its maliciousness are taken into consideration.	2-4 years
4. Cases in which the research funds were used to attain personal economic gain, regardless of 1 to 3.	10 years
5. Cases in which dishonest means, such as deceit, were used to have the research project in question selected for the program.	5 years
6. Although not directly involved in the inappropriate use of research funds, cases in which the use of research funds is deemed to have violated the due care of a prudent manager.	1-2 years

Note: With regard to research projects newly selected in or after FY2013, the period of limitation on the researcher changed greatly with the toughening of the "Guidelines for the Appropriate Implementation of Competitive Research Funding" (revised March 27, 2009 by mutual agreement of the Liaison Conference among Relevant Ministries and Agencies on Competitive Funding). The above table shows limitations periods after the change.

6.4 Implementation of Proper Systems for Managing and Auditing Research Funds at Research Institutions

○ Based on the "Guidelines for the Management and Auditing of Public Research Funds by Research Institutions (Performance Criteria)" (decided by the Minister of Education, Culture, Sports, Science and Technology on February 15, 2007), research institutions need to improve their systems for managing and auditing contract research funds.

For details of the "Guidelines for the Management and Auditing of Public Research Funds by Research Institutions (Performance Criteria)", please refer to the following website.

http://www.mext.go.jp/b_menu/shingi/chousa/gijyutu/008/houkoku/07020815.htm

○ Submission of a "Self-evaluation Checklist for Implementation of Proper Systems" based on the "Guidelines for the Management and Auditing of Public Research Funds by Research Institutions (Performance Criteria)"

When concluding agreements for participation in this program, each research institution*1 is required to implement proper systems for managing and auditing research funds based on the guidelines mentioned above, as well as to submit a "Self-evaluation Checklist for Implementation of Proper Systems" (hereinafter referred to as the "checklist"), which is a report on the status of these improvements. (If no checklist is submitted, implementation of the research cannot be approved.)

*1 Under CREST, this refers to not only the research institution with which the Research Director is affiliated but also the research institutions to which the Main Research Collaborator who are receiving research funding.

Consequently, each research institution must submit a checklist via the Cross-ministerial R&D Management System (e-Rad) to the Ministry of Education, Culture, Sports, Science and Technology's Bureau of Science and Technology Policy Research and Coordination Division Financial Resource Coordination Office based on the format provided on the website mentioned below by the date the research commences (the date the agreement is concluded).

For details on how to submit a checklist, please refer to the following Ministry of Education, Culture, Sports, Science and Technology website.

http://www.mext.go.jp/a_menu/kansa/houkoku/1301688.htm

Since in order to submit the checklist it is necessary to have an environment that enables use of e-Rad, research institutions that have not already carried out registration procedures for e-Rad should do so as soon as possible. Please note that registration usually takes around two weeks. For details on the procedures for using e-Rad, please refer to the following website in addition to the submission methods explained on the homepage mentioned above.

http://www.e-rad.go.jp/shozoku/system/index.html

However, in the case that your research institution has submitted a checklist on a separate occasion after April 2011, there is no need to submit a checklist on this occasion.

In addition, in the case that the research project is to be continued in and- beyond FY2013, resubmission of checklists is scheduled for around autumn 2012, so please take careful note of any notifications received from the Ministry of Education, Culture, Sports, Science and Technology.

Following submission of the checklist, research institutions may be required by the Ministry of Education, Culture, Sports, Science and Technology (including funding agencies) to cooperate with conducting on-site examinations of system implementation if necessary.

Furthermore, with regard to checklist content, in the case that measures to address the "mandatory items" indicated in the notification by the Director General, Science and Technology Policy Bureau dated May 31, 2007, are deemed inappropriate or insufficient, and it is deemed that these problems have not been resolved, the research funds may not be granted.

6.5 Measures against Misconduct in Research Activities

○ In accordance with the "Guidelines for Responding to Misconduct in Research Activities" (August 8, 2006; Council for Science and Technology Special Committee on Research Activities), measures against misconduct in research activities (fabrication, manipulation, plagiarism, etc.) shall be as follows. For details of the "Guidelines for Responding to Misconduct in Research Activities", please refer to the website below.

http://www.mext.go.jp/b_menu/shingi/gijyutu/gijyutu12/houkoku/06082316.htm

○ With regard to research projects under this program, in the case that misconduct in research activities is discovered, the research project in question may be cancelled; all or part of the project's research funding returned, and measures taken to publicize the facts of the matter. Furthermore, limitations shall be placed for a certain period of time on the eligibility of those listed below to apply to or newly participate in this program.

As a general rule, the period of limitations shall be between one and ten years. Note that "application or participation" refers to the submission of proposals, applications, and requests for new research projects by the researcher or participation in new research by the researcher as a joint researcher.

<table>
<tr><th colspan="3">Classification According to Involvement in Misconduct</th><th>Extent of Misconduct</th><th>Period Deemed Appropriate</th></tr>
<tr><td rowspan="5">Person Involved in the Misconduct</td><td colspan="2">1. Especially malicious individual who intentionally engages in misconduct from the outset of the research</td><td></td><td>10 years</td></tr>
<tr><td rowspan="3">2. Author of academic paper, etc. related to research in which there has been misconduct</td><td rowspan="2">The author responsible for the academic paper in question (supervisor, first author, or other position of responsibility deemed equivalent)</td><td>The impact on the advancement of research in the relevant field or society is large, and the maliciousness of the misconduct is deemed to be high.</td><td>5-7 years</td></tr>
<tr><td>The impact on the advancement of research in the relevant field or society is small, and the maliciousness of the misconduct is deemed to be low.</td><td>3-5 years</td></tr>
<tr><td>Author other than that listed above</td><td></td><td>2-3 years</td></tr>
<tr><td colspan="2">3. An individual involved in misconduct other than that stipulated in 1 or 2</td><td></td><td>2-3 years</td></tr>
<tr><td colspan="3" rowspan="2">An author responsible for academic papers, etc. related to research in which there has been misconduct but who was not involved in the misconduct (supervisor, first author, or other position of responsibility deemed equivalent)</td><td>The impact on the advancement of research in the relevant field or society is large, and the maliciousness of the misconduct is deemed to be high.</td><td>2-3 years</td></tr>
<tr><td>The impact on the advancement of research in the relevant field or society is small, and the maliciousness of the misconduct is deemed to be low.</td><td>1-2 years</td></tr>
</table>

Note: With regard to research projects newly selected in or after FY2013, the periods of limitation on the researcher were changed in order to standardize their application with other competitive funding, etc. with the revision of the “Guidelines for the Appropriate Implementation of Competitive Research funding” (revised

October, 2012 by mutual agreement of the Liaison Conference among Relevant Ministries and Agencies on Competitive Funding). The above table shows limitations periods after the change.

○Limitations shall be placed for a certain period of time on eligibility for application to or participation in this program for researchers who have been reprimanded for misconduct in research activities conducted under other competitive research funding operated by the national government or independent administrative agencies (see Footnote 3) or programs other than competitive funding programs that are under the jurisdiction of the JST and to whom limitations on application/participation eligibility for the relevant program have been applied.

(Limitations shall also be placed on participation for the fiscal year in which the misconduct in research activities is deemed to have occurred. Moreover, limitations may be applied retroactively.)

○In the case that misconduct in research activities conducted under this program is discovered, information regarding the details of the misconduct by the researcher in question is provided to those in charge of other competitive funding programs (including independent administration agencies). Consequently, limitations may be placed on application to or participation in other competitive funding programs (see Footnote 3).

6.6 Measures for Protecting Civil Rights and Complying with Laws and Regulations

In the case that, in implementing a research initiative, the initiative involves research requiring the consent/cooperation of other parties, research requiring particular care in handling personal information, research requiring bioethical or safety measures to be taken, and other research requiring procedures required by laws and regulations, be sure to carry out the necessary procedures, such as obtaining the approval of an external and internal ethics committee of a research institution.

With regard to life science-related research in particular, the main laws and regulations prescribed by each government ministry are as follows. Please note that, depending on the research content, there are also cases in which laws and regulations other than these have been established.

- Act on Regulation of Human Cloning Techniques (Act No. 146 of 2000)
- Guidelines for Handling of a Specified Embryo (Public Notice of Ministry of Education, Culture, Sports, Science and Technology No. 83 of 2009)
- Guidelines on the Derivation and Distribution of Human Embryonic Stem Cells (Public Notice of Ministry of Education, Culture, Sports, Science and Technology No. 156 of 2009)
- Guidelines on the Utilization of Human Embryonic Stem Cells (Public Notice of Ministry of Education, Culture, Sports, Science and Technology No. 87 of 2010)
- Ethical Guidelines for Human Genome/Gene Analysis Research (Public Notice of Ministry of Education, Culture, Sports, Science and Technology/ Ministry of Health, Labour and Welfare/ Ministry of Economy, Trade and Industry No. 1 of 2001)
- Ministerial Ordinance on Good Clinical Practice for Drugs (Ordinance of Ministry of Health, Labour and Welfare No. 68 of 2009)
- R&D Using Human Tissue Extracted during Operations, Etc. (Report of the Health Science Council 1998)
- Ethical Guidelines for Epidemiological Research (Public Notice of Ministry of Education, Culture, Sports, Science and Technology/ Ministry of Health, Labour and Welfare No. 1 of 2007)
- Guidelines for Gene Therapy Clinical Research (Public Notice of Ministry of Education, Culture, Sports,

Science and Technology/ Ministry of Health, Labour and Welfare No. 2 of 2004)

- Ethical Guidelines for Clinical Studies (Public Notice of Ministry of Health, Labour and Welfare No. 415 of 2008)
- Act on the Conservation and Sustainable Use of Biological Diversity through Regulations on the Use of Living Modified Organisms (Act No. 97 of 2003)

For information regarding Ministry of Education, Culture, Sports, Science and Technology measures on bioethics and safety assurance, please refer to the following website.

Life Sciences no Hiroba "Measures on Bioethics and Safety Assurance" website
http://www.lifescience.mext.go.jp/bioethics/index.html

In the case that the research plan includes research or surveys that require consent/cooperation of other parties and/or social consensus, be sure to take appropriate measures for protecting civil rights and interests prior to applying to this program.

6.7 Security Export Control (Measures against the Leakage of Technology Internationally)

○ Many cutting-edge technologies are studied at research institutions. Universities in particular have seen an increase in the number of international students and foreign researchers due to internationalization, and there is an increasing risk of cutting-edge technologies and/or research materials/equipment being leaked or used for bad purposes such as the development and production of weapons of mass destruction. For this reason, in carrying out their various research activities, including the relevant contract research, research institutions are required to take organizational measures to ensure that research results that could be used for military purposes do not fall into the hands of people who could carry out fearful activities such as developers of weapons of mass destruction or terrorist groups.

○ In Japan there are export controls* based on the Foreign Exchange and Foreign Trade Act (Act No. 228 of 1949) (hereinafter referred to as the "Foreign Exchange Act"). Accordingly, when attempting to export (provide) goods or technologies controlled by the Foreign Exchange Act, as a general rule it is necessary to obtain the license of the Minister of Economy, Trade and Industry. Be sure to comply with the Foreign Exchange Act and other laws, ministerial ordinances, and notices issued by government ministries and agencies.

*Currently, Japan's security export control system mainly comprises two systems based on international consensus: (1) systems under which the license of the Minister of Economy, Trade and Industry is required as a general rule when attempting to export (provide) goods (technologies) with specifications/functions that are above certain criteria, such as carbon fibers or numerically-controlled machine tools (list control); and (2) systems under which the license of the Minister of Economy, Trade and Industry is required when attempting to export (provide) goods (technologies) to which list controls do not apply and certain requirements (use application requirements, end-user requirements, and notification (inform) requirements) have been met (catch-all control).

○ Not only the export of goods but also the provision of technology is subject to Foreign Exchange Act controls. When providing list control technologies to foreigners (non-residents), license to provide the information must be obtained in advance. "Technology provision" includes the provision of technology information such as blueprints, specifications, manuals, specimens, and prototypes by means of storage media such as paper, e-mail, CD, and USB memory, and also includes the provision of operational knowledge through technical guidance and skills training as well as technological support through seminars. There are also cases in which technology provision includes a large amount of technology exchange that could be subject to Foreign Exchange Act controls in the acceptance of international students and joint research activities.

○ Detailed information about security export control is provided on the website of the Japanese Ministry of Economy, Trade and Industry (METI) and other organizations. Please see the list below for details.

- Ministry of Economy, Trade and Industry (METI): Security export control (general)
  http://www.meti.go.jp/policy/anpo/
- Ministry of Economy, Trade and Industry (METI): Security Export Handbook
  http://www.meti.go.jp/policy/anpo/seminer/shiryo/handbook.pdf
- Center for Information on Security Trade Control
  http://www.cistec.or.jp/index.html
- Guidance on machine technology control in relation to security export control (for universities/research institutions)
  http://www.meti.go.jp/policy/anpo/law_document/tutatu/t07sonota/t07sonota_jishukanri03.pdf

6.8 Support for National Bioscience Database Center

We request that all participants in this project in the field of life science submit copies of the raw data used to produce the outcomes presented in scientific papers or copies of the database for publication to the National Bioscience Database Center (*). The submitted copies shall be used non-exclusively in the necessary formats for copies and modified forms. We may request the submission of the necessary information for copies if the parties receiving the copies demand it.

(*) National Bioscience Database Center (http://biosciencedbc.jp/)

The National Bioscience Database Center was established in the JST in April 2011 for the purpose of promoting the integrated use of databases in the field of life science produced by various research facilities. The database task force of the Council for Science and Technology Policy had discussions on the center, which plays the core function of integrating databases in the field of life science in Japan. Based on the discussions, the National Bioscience Database Center was established as an integration of the Integrated Database Project of the Ministry of Education, Culture, Sports, Science and Technology, which was implemented from fiscal year 2006 to 2010 and the JST’s Institute for Bioinformatics Research and Development, which has been operating since 2001. The National Bioscience Database Center encourages active participation by the relevant agencies. At the same time, the Center implements operations toward the integration of databases in the field of life science in four fields of operation: proposal of strategies, construction and operation of portal sites, research and development of fundamental technologies for integrating databases, and integration of bio-related databases. The Center aims to invigorate overall life science research, including basic research and applicable research that result in industrial applications as the outcomes of life science research in Japan are shared and used in the community by a wide range of researchers.

6.9 Efficient promotion of research and development through effective use of currently available research facilities and equipment

The Ministry of Education, Culture, Sports, Science and Technology is promoting the development of the grounds for sharing research institutes and facilities and integrating different research fields in accordance with the Act on the Promotion of Public Utilization of the Specific Advanced Large Research Facilities (Act No. 78 of June 29, 1994); the Act on Enhancement of Research and Development Capacity and Efficient Promotion, etc., of Research and Development, etc., by Advancement of Research and Development System Reform (Act No. 63 of June 11, 2008); and other laws. If the uses and purchases of research facilities and equipment are being considered upon the application, please consider actively using facilities and equipment owned by universities and independent administrative institutes and made available to others and opportunities for cooperation among industries, academia, and the government from the perspective of effective promotion of consigned research in this program; effective use of already available facilities and equipment; and removing overlaps in purchasing facilities and equipment.

<Reference: Examples of shared facilities and equipment>

○Facilities covered in the Act on the Promotion of Public Utilization of the Specific Advanced Large Research Facilities

・SPring-8, the large synchrotron radiation facility (Applications are accepted around May and November every year.)
http://user.spring8.or.jp/?lang=ja

・SACLA, an X-ray free-electron laser facility (Applications are accepted around May and November every year.)
http://sacla.xfel.jp/

・J-PARC, a large intensity proton accelerator (Applications are accepted around May and November every year.)
http://is.j-parc.jp/uo/index.html

・Kei supercomputer (Shared use is expected to start in the autumn of 2012, and applications for using this facility are planned to start in May 2012.)
http://www.aics.riken.jp/

*Please refer to the website of registered agencies for the promotion of facility uses for information on the application of projects to use these facilities.
(The website is being prepared.)

○Projects for promoting the sharing of advanced research facilities (targeted for 28 facilities)
http://kyoyonavi.mext.go.jp/

○Nano technology platform (the project is expected to start in July 2012)
http://www.mext.go.jp/b_menu/boshu/detail/1316537.htm

○Development of research base network toward the construction of a low-carbon society (three hub bases and 15 satellite bases)
http://www.nims.go.jp/lcnet/

○Tsukuba Innovation Arena (TIA-nano)
http://tia-nano.jp/

○Project for technical base platform for supporting pharmaceutical development and other developments (three bases)
http://p4d-www.genes.nig.ac.jp/index.html

6.10 Results from JST's Program "Development of Systems and Technology for Advanced Measurement and Analysis"

Under JST's Program "Development of Systems and Technology for Advanced Measurement and Analysis", a lot of tools for research and development have been put into practical use. In promoting research and development, please use the following website for your reference.
http://www.jst.go.jp/sentan/en/index.html

Chapter 7 Duplicated Applications for JST Programs

Duplicate applications to other programs within the Basic Research Programs or related JST programs are restricted as follows.

(1) Only one application may be submitted across all CREST and PRESTO Research Areas in Research Proposal Applications.

(2) If you are in any of the following positions, as a rule, do not apply. (Except that the ending time period of the concerned ongoing research is finished before March 31, 2014.)
a. Common to CREST and PRESTO
・ Research Director of ERATO (Supervisor-Oriented Research) in the Basic Research Programs
・ Research Director of CREST (Team Research) in the Basic Research Programs
・ Researcher of PRESTO (Individual Research) in the Basic Research Programs
・ Research Director of ALCA in the Basic Research Programs
b. Only PRESTO
・ Team Leader of Development of Systems and Technology for Advanced Measurement and Analysis
・ Leader of S-Innovation Program at the R&D stage I
・ Research Director of Collaborative Research Based on Industrial Demand

(3) For CREST, Multiple applications from one researcher by switching from Research Director to Main Research Collaborator, or vice versa are not allowed.

(4) Currently-active PRESTO researchers cannot participate as Main Research Collaborator for CREST. (Except that ongoing PRESTO research is finished before March 31, 2014.) In case those who are applying to PRESTO and also applying to CREST as a Main Research Collaborator, and both research proposals are short-listed, they have to reconsider their role in CREST or select one project to engage, and so on.

(5) Those who are applying to ALCA as a Research Director and also applying to CREST or PRESTO, they can be selected in only one program of three programs (CREST, PRESTO or ALCA).

(6) If you are applying for PRESTO and simultaneously applying for Development of Systems and Technology for Advanced Measurement and Analysis as a Team Leader or S-Innovation Program as a Leader, one of either will be selected upon consultation when multiple applications are short-listed.

(7) If the applicant's research proposal has been short-listed for FY2013 CREST or PRESTO programs and as a result, the applicant will participate in multiple research projects in JST's competitive research funds, adjustments among research projects may be enforced. For example, the research expenses for the applicant's project(s) may be reduced the applicant may be invited to select only one among the projects. (Except if the concerned ongoing research is finished before March 31, 2014 and the research subjects was selected before FY2012). In the case of proposals for CREST, such adjustments may be subjected to not only Research Director but also the participants.

Chapter 8 Recruiting via the Cross-ministerial R&D Management System (e-Rad)

8.1 Recruiting via the Cross-ministerial R&D Management System (e-Rad)

Calls for research proposal applications are made via the e-Rad (http://www.e-rad.go.jp/)[10] system. The process for submitting research proposal applications via e-Rad is described below.

(1) Enter information on the research institution and researcher

Applicants who do not have a login ID or password must request the administrative section of their research institution to register the institution in the e-Rad system. It should be noted that the registration process can take more than two weeks. →For more details, please refer to 8.3(1).

↓

(2) Obtain application requirements and research proposal forms

Check the list of current calls for research proposal applications on the e-Rad portal site (http://www.e-rad.go.jp/), and download the application requirements and research proposal forms. → For more details, please refer to 8.3(2).

↓

(3) Prepare a research proposal (maximum file size of 3 MB） → For more details, please refer to 8.3(3).

↓

(4) Enter the required information into the e-Rad system

Enter the required information into the e-Rad system. → For more details, please refer to 8-3(4).

↓

(5) Submit the research proposal

Submit your research proposal by uploading it. → For more details, please refer to 8.3(5).

The e-Rad system can become extremely busy just before submission deadlines. This can result in significant delays for the entry of information and uploading of research proposals. Furthermore, given specification changes, like the newly adopted requirement that applicants now submit research proposals as PDF files and the increase in information to be entered into the e-Rad system, Applicants are advised to allow several days for completing the process for submitting research applications.

PRESTO:

Submission deadline: June 11, 2013 (Tue.) 12:00 noon

CREST:

Submission deadline: June 13, 2013 (Thu.) 12:00 noon

↓

(6) Receipt by JST → For more details, please refer to 8.3(6).

[10] The e-Rad system is a cross-ministerial system that enables online completion of all processes (Application receipt → Evaluation → Selection → Management of selected research topics → Reporting of results, etc.) related to the management – referring primarily the competitive funding systems overseen by individual ministries - of research and development. "e-Rad" is derived from the words "electronic" and "research and development" (for science and technology).

8.2 System Availability and Where to Direct Questions

(1) How to use the e-Rad system

An instruction manual explaining how to use the e-Rad system can be downloaded from the e-Rad portal site (http://www.e-rad.go.jp/). Please submit research proposals after accepting the terms of the e-Rad user agreement.

(2) Where to direct questions on how to use the e-Rad system

Questions regarding JST's systems and programs should be directed to JST. Questions on how to use the system should be directed to the e-Rad helpdesk.

Please read carefully the explanation of the application process contained in this chapter, and the contents of the e-Rad portal site, before submitting a question. It should be noted that questions regarding the progress of application evaluations and whether an application has been accepted or rejected will not be answered under any circumstances.

Questions regarding matters like systems and programs, preparation of documentation for submission, and submission procedures	JST Department of Innovation Research (Person in charge of calls for proposals)	Please submit questions by e-mail (Questions will be accepted by more direct means in urgent situations.) E-mail : rp-info@jst.go.jp (For matters related to proposal submission) Tel : 03-3512-3530 (For matters related to proposal submission) Hours: 10:00-12:00 / 13:00-17:00 ●Except on Saturdays, Sundays, and holidays
Got questions regarding use of the e-Rad system	e-Rad helpdesk	0120-066-877 9:00-18:00 ●Except on Saturdays, Sundays, and holidays

- Website for this program: (http://www.senryaku.jst.go.jp/teian.html)
- e-Rad portal website (http://www.e-rad.go.jp/)

(3) e-Rad system availability

Monday to Sunday 0:00-24:00 (24 hours a day, 365 days a year)

The e-Rad system is basically available 24 hours a day, 365 days a year, but is occasionally taken down for maintenance and inspections. Maintenance and inspection schedules are announced ahead of time on the portal site.

8.3 Detailed Submission Instructions and Precautions

8.3.1 Entering information on research institutions and researchers

Researchers applying to be a CREST Research Director, CREST Lead Joint Researcher, or PRESTO individual researcher must first obtain an e-Rad login ID and password.

For researchers affiliated with a domestic research institution, prior registration of information on the research institution and researcher must be completed by the administrative section of the research institution. For researchers affiliated with a foreign research institution, and researchers affiliated with no research institution, prior registration of information on the researcher must be completed by the applicant. For more information on how to register information, refer to the e-Rad portal site (“System usage requirements,” “FAQs,” etc.).

Please note that the registration process can require several days and it is advisable to set aside over two weeks for completing it. If registration via a system or program of another ministry or other government organization has already been completed, doing so once again is not required.

Figure　e-Rad portal site top page

8.3.2 Obtain application requirements and research proposal forms

■ e-Rad login

Click “e-Rad login” on the portal site (http://www.e-rad.go.jp/).

Figure　e-Rad portal site

Log in using the applicant’s login ID and password.

➢ Once this is done, information on the researcher who has logged in will be automatically displayed in areas showing information on the Research Director.

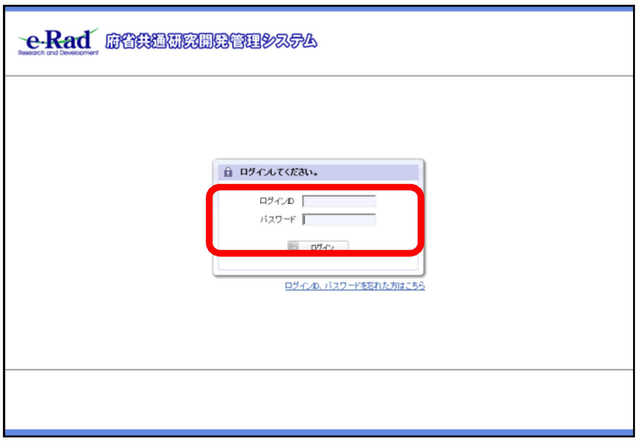

Figure　Login screen

For first-time logins, it is necessary to enter initial settings. In addition, when logging in from a PC other than the one normally used for login, the login process will go to an additional authentication screen. On such occasions, the user may be asked to respond to a preset question.

Figure (Reference)　Initial login screen

■ Search for calls for proposals

Click on 1) “Application / Selection Information Management” on the left-side menu. Next, click on 2) “List of

Current Calls for Proposals.”

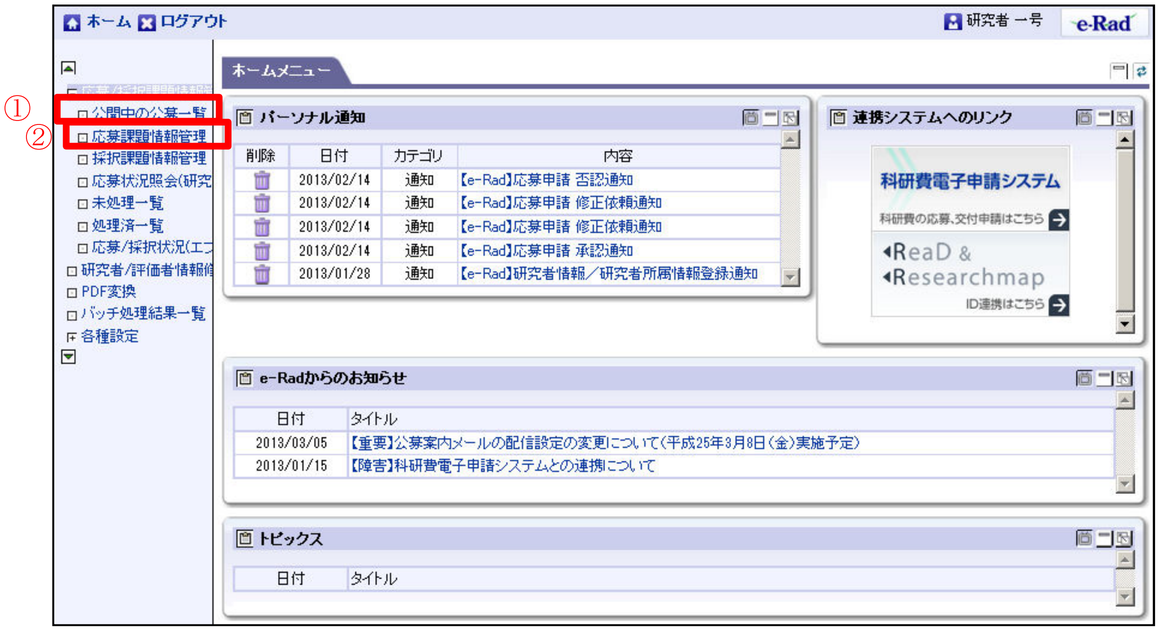

Figure　Researcher menu screen

Click on “Details” for the call for proposals for which an application will be submitted. Make sure everything is correct in terms of the call-for-proposals selection, CREST or PRESTO category, and research area.

➢ Simple searches can be performed by clicking “Search Conditions”. (Please search based on terms such as system name, research area, and Research Supervisor.)

Figure　List of current calls for proposals

■ Download the research proposal forms and application requirements

Confirm that the call for proposals, CREST / PRESTO category, and research area are correct.

For the research proposal forms, click "Application Form File" and download the file. Application forms may differ depending on the research area. **Be very careful to use the correct forms for the research area for which the application will be submitted.**

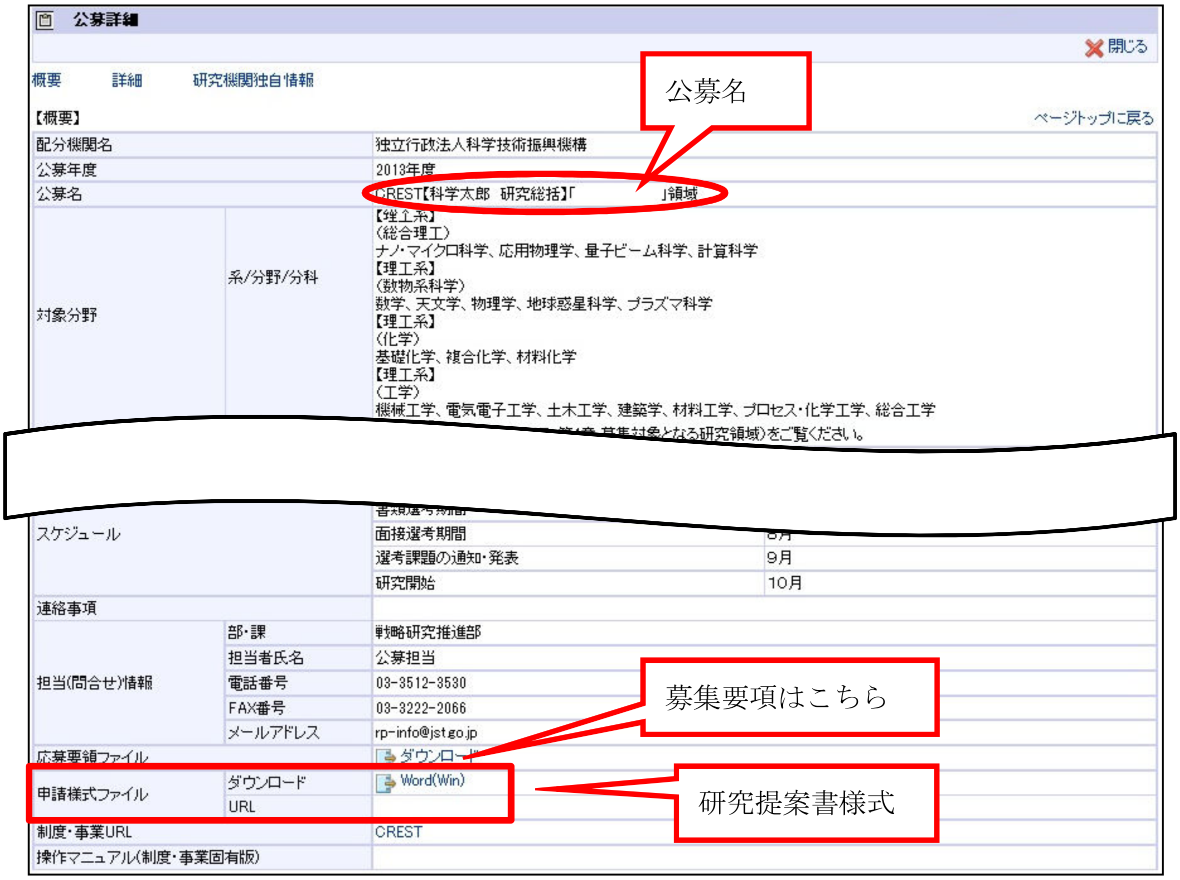

Figure　Details of a call for proposals

Application requirements (application requirements for the call for proposals) can be accessed from the same page. (Click on “Application Requirement File” to download the requirements.)

8.3.3 Preparing a Research Proposal

- Make sure that application requirements are understood before preparing a research proposal.
- When entering application information into the system, refer to the researcher's manual posted on the portal site.
- To paste image files into a research application form, use only the GIF, BMP, or PNG formats. Image data pasted in other file formats will not be correctly converted to the PDF format. For more information on how to paste image data, refer to the researcher's manual.
- Research proposals (doc format) must be converted to the PDF format before uploading to the e-Rad system. PDF conversion can be performed using the menu that appears after login. It is also possible to download the conversion software from the same menu and install it on the researcher's computer.
  - ➢ In the process of conversion, characters, such as those used in certain languages and special characters, may not be rendered correctly. It is necessary, therefore, to check all PDF files within the system. For more information on characters available for use, please refer to the "Usage Manual for Researchers" (downloadable from the e-Rad portal site).
  - ➢ <u>When creating PDF files, do not set a password for the research proposal.</u>
  - ➢ <u>Delete the conversion history.</u>
  - ➢ Make sure that page numbers have been attached to the file converted to PDF format.

- Research proposals converted to the PDF format should be no larger than 3MB. Files exceeding 10MB cannot be uploaded to the e-Rad system.

Figure PDF conversion

8.3.4 Entering the Required Information into the e-Rad System

■ Search for calls for proposals

After preparing a research proposal, log in once again, search for calls for proposals (Procedure is the same as in (2)) and click “Enter Application Information.”

※ Please note that it is not possible to submit multiple applications for the same research area.

Figure　List of current calls for proposals

■ Application conditions

After reading the cautionary note, click "Agree” on the upper left portion of the screen.

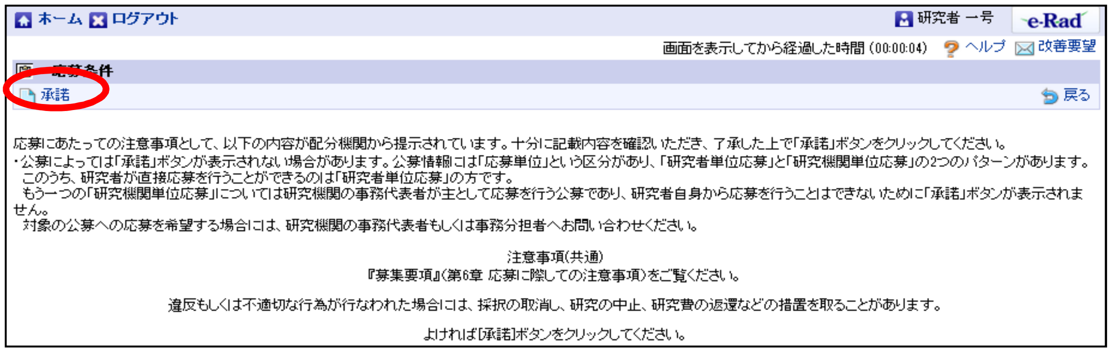

Figure　Application conditions

■ Enter application information

Enter the various types of information required to apply.

This screen is organized with tabs. Clicking the eight tabs shown below will display a related data entry screen.

- Confirm that the call for proposals, CREST / PRESTO category, and research area are correct.
- In the space labeled “R&D Subject,” enter the "Research Project Name” from Research Proposal (Form 1).

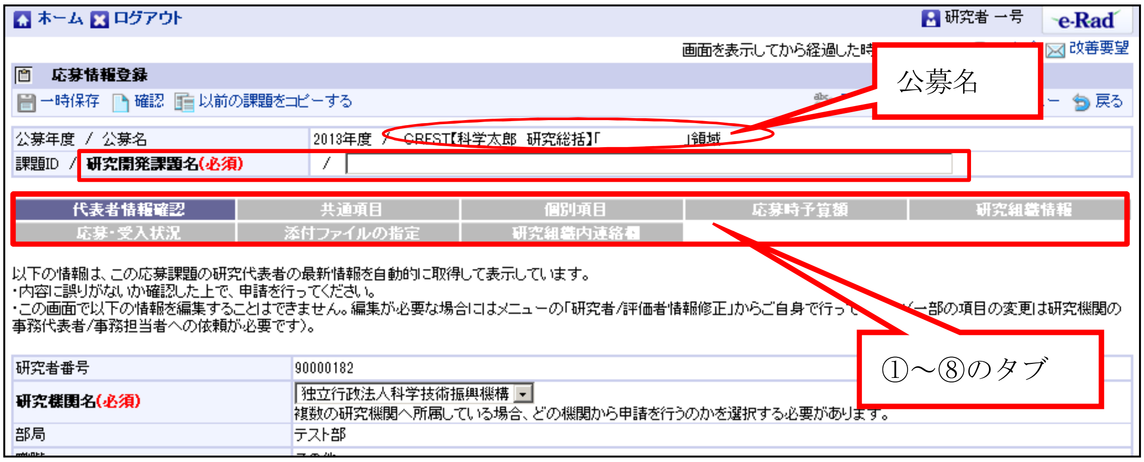

Figure　Application information data entry screen (Accessed by clicking the “Research Director Information Confirmation” tab)

1)　“Research Director Information Confirmation” tab

- Check whether the information on the Research Director is correct. Information registered on the e-Rad system is automatically entered. (Corrections cannot be made on this screen. Information revisions must be made by the person making the proposal or by the administrative section of the research institution with which he / she is affiliated. This is done by clicking on the “Revise Researcher / Evaluator Information” on the menu. For more details, refer to the Usage Manual for Researchers.)
- Researchers who are affiliated with multiple research institutions must select the institution from which the proposal will be made. This selection is made via this tab.

Figure　Research Director Information Confirmation tab

2) “Common Items” tab

Figure　“Common Items” tab

Research Period (Start): 2013 (Fiscal year)

Research Period (End) (3 1/2 year projects): 2016 (Fiscal year)

Research Period (End) (5 1/2 year projects): 2018 (Fiscal year)

Research Field (Main, Secondary) / Specific Name: Click “Search” and use the new screen to perform a detailed search for the research field / specific name that apply to the proposed research. Select the appropriate items.

Research Field (Main, Secondary) / Keywords: After selecting a specific name, select keywords from the list.

Research Objectives: Enter "Refer to the research proposal."

Research Overview: Enter "Refer to the research proposal."

3) “Individual Items” tab

Enter information for affiliation category, institutional affiliation, department affiliation, job title, contact category, postal code, address, telephone number, e-mail address, form of participation (PRESTO only), and the survey question as indicated on the screen. (Placing the cursor over each item will cause a related explanation to appear. Please refer to these as necessary.)

➢ For CREST applications, enter information on the Research Director.

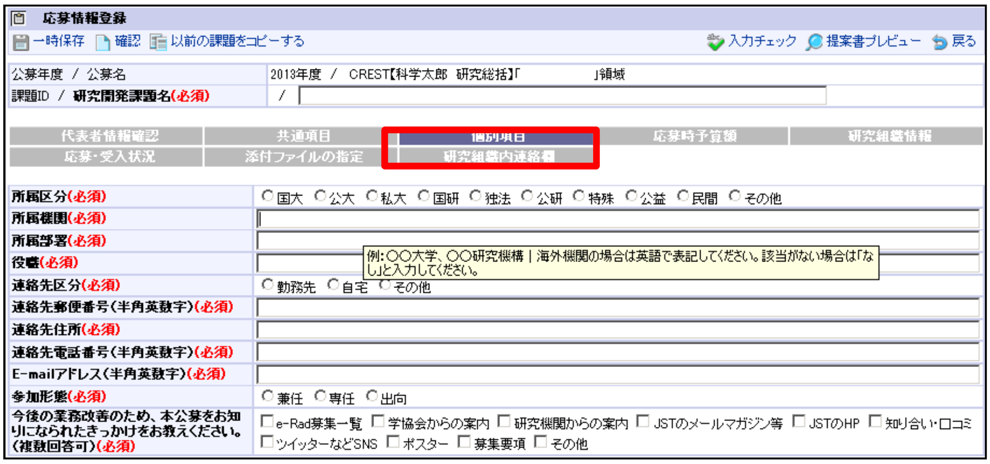

Figure “Individual Items” tab

(PRESTO only)

Form of Participation: Select one.

(Joint Appointment): For researchers affiliated with a university or independent administrative agency research institution, or national and public testing and research institution, or private company

(Exclusive Appointment): For postdoctoral fellows and researchers who will resign or take leave from the research institution with which they are currently affiliated

(Temporary Transfer): For researchers affiliated with the research institution of a private company, foundation, etc.

4) Budget at Application Time" tab

Direct Cost (CREST): Enter the yen-denominated team total cost figures for each fiscal year from "Itemized Research Cost Plan (team)" on Research Proposal (Form 6).

Direct Cost (PRESTO): Enter the yen-denominated cost figures for each fiscal year from "Desired Research Budget" on Research Proposal (Form 1).

- ➢ Direct cost breakdowns are not required.

Overhead Cost (Indirect Cost): Enter "0" (1,000s of yen) for each fiscal year.

- ➢ The fiscal years for the research period entered under the "Common Items" tab (2) above) will be displayed.
- ➢ (CREST only) If the figure for the initial fiscal year (2013) under this tab does not equal the total for the Research Director and all Lead Joint Researchers under the "Research Organization Information" tab (5) below), an error will result.

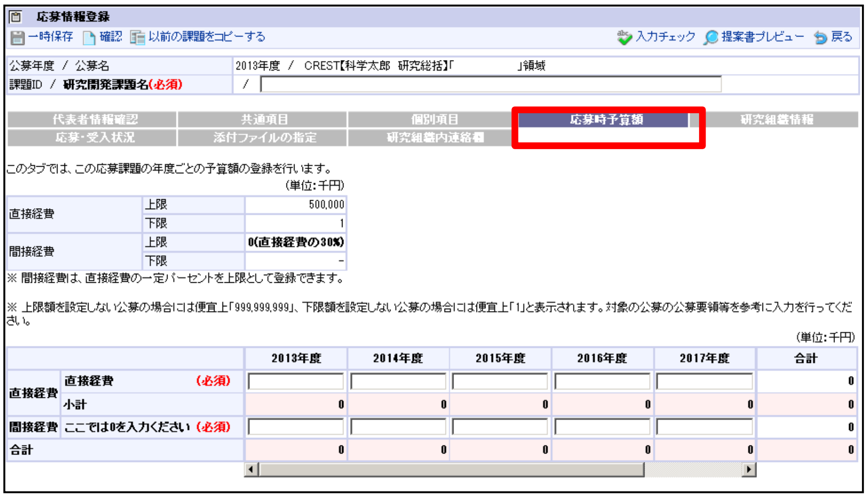

Figure "Budget at Application Time" tab

5) "Research Organization Information" tab

Direct Cost （CREST）: Enter the "Initial Fiscal Year (2013) Research Cost for the Research Director's Group" from the "Research Budgets for Individual Research Group" on Research Proposal (Form 6). Round to the nearest 1,000 yen.

Direct Cost (PRESTO): Enter the desired budget figure for the initial fiscal year (2013). Round to the nearest 1,000 yen.

- Direct cost breakdowns are not required.

Overhead Cost (Indirect Cost): Enter "0" (1,000s of yen).

Field of Specialization: Enter in concise terms.

Role: Enter "Research Director" or "Lead Joint Researcher."

Effort: Enter the amount of financing that is anticipated from other sources if the proposal is selected. (For CREST, this should be the same figure as appears on Research Proposal (Form 4 (5 Lead Joint Researchers)). For PRESTO, this should be the same figure as appears on Research Proposal (Form 5).

- (CREST only)

- When there are Lead Joint Researchers, click "Add" in the lower portion of the screen to enter data for them. Enter researcher information in the same manner information was entered for the Research Director.
- If the figure for the initial fiscal year (2013) under the "Budget at Application Time" tab (4) above) and the total for the Research Director and all Lead Joint Researchers under this tab are not equal, an error will result.
- If registration of the Lead Joint Researchers cannot be completed on the e-Rad system by the deadline, as a provisional measure, enter a total cost figure when entering data for the Research Director. Once the application has been submitted, send the yet-to-be entered information on the Lead Joint Researchers as quickly as possible to rp-info@jst.go.jp.

Figure “Research Organization Information” tab

6) “Application and Acceptance Status” tab

No entries are required for this tab.

※ For “Support from Other Organizations, etc.,” enter the information from Research Proposal (Form 10) for a CREST application, or the information from Research Proposal (Form 5) for a PRESTO application.

7) “File Attachment” tab

Click “Choose” to select and upload the PDF created in (3) Preparing a Research Proposal.

Figure “File Attachment” tab

8) “Internal Research Organization Contact Information” tab

This information will not be used in CREST / PRESTO examinations.

8.3.5 Research Proposal Submission

After entering the required information under tabs 1) through 5) and 7), click “Confirm” in the upper left portion of the screen.

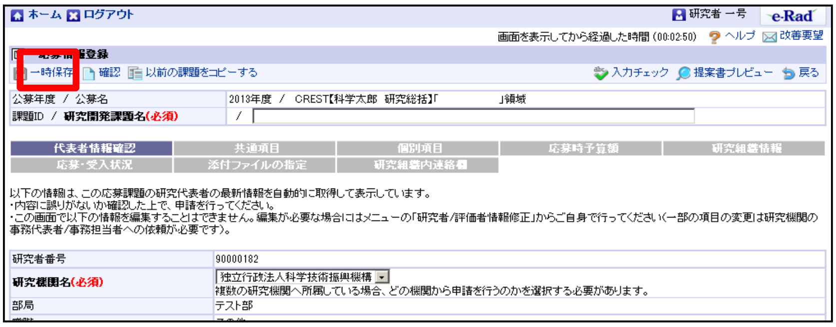

Figure　Application information submission (Confirmation)

※ When corrections are needed to provide information for required items left blank or information entries that do not conform to rules, the tabs including such places will be displayed in red characters and the specific cells requiring correction will be displayed in the yellow. An error message will be displayed at the top of the screen. Make corrections in accordance with the information in this message.

Confirm that all entered information is being correctly displayed and click on “Submit” in the upper left portion of the screen to submit the proposal. Substantial time is required to complete the submission process in some cases.

If the submission is successful, a message reading “Application Information Receipt Finalized” will be displayed. At that point, the Research proposal has been submitted to JST. It should be noted that CREST / PRESTO do not require that the research institutions with which researches are affiliated provide approval via the e-Rad system.

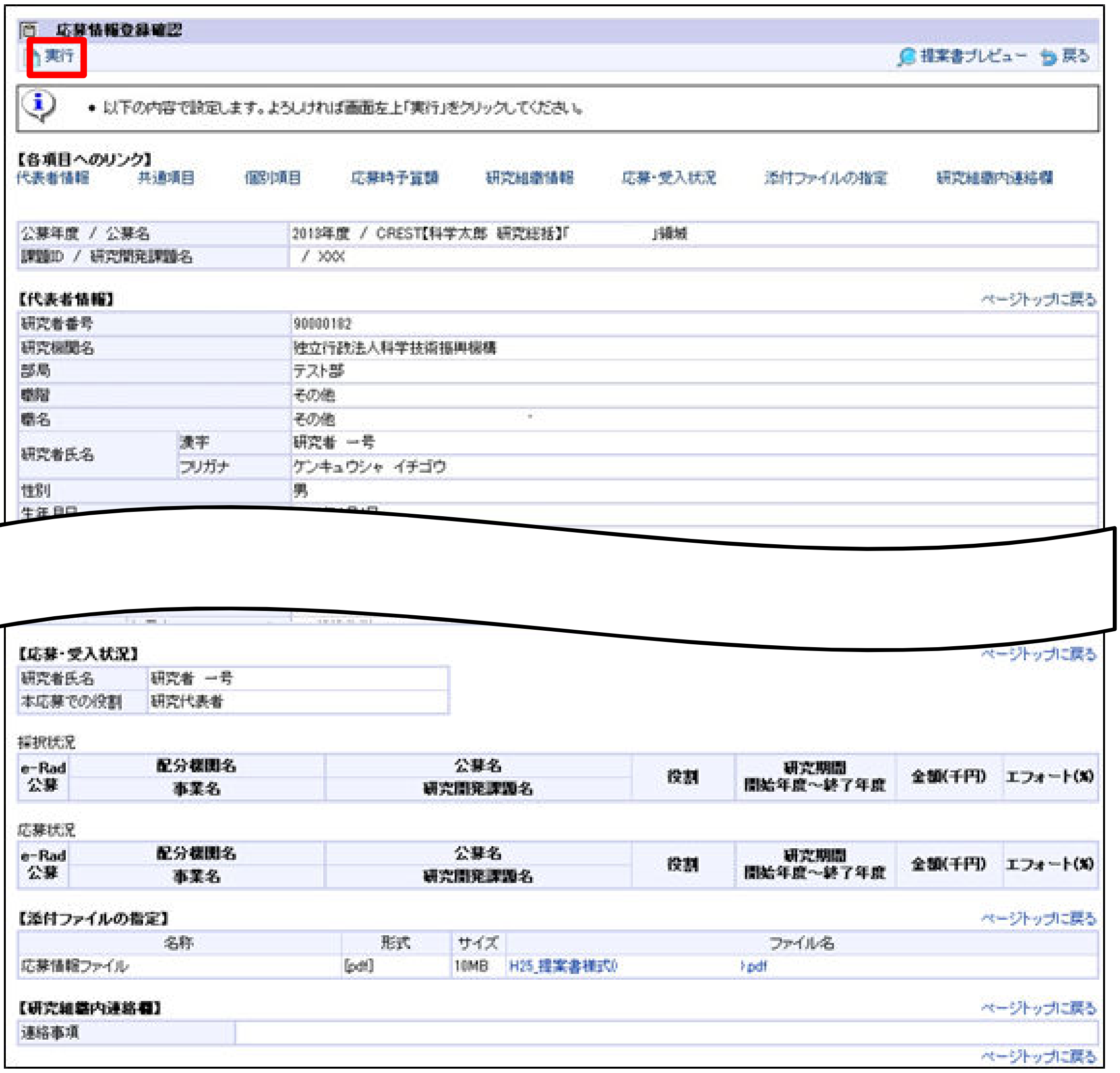

Figure　Final application information entry confirmation

■ Confirmation of application information status

After clicking “Application / Selection Information Management” on the left-side menu (1) below), click “Application Information Management” (2) below).

Check whether the status of the call for proposals for which the application was submitted is described as “Processing.” Applications not submitted by the deadline are invalid. If a “Processing” message is not received by the submission deadline, despite compliance with submission rules, send a message to rp-info@jst.go.jp.

Figure　Application information management (Processing)

8.3.6 Receipt by JST

When a research proposal has been received by JST, the application status is shown as “Application Complete” or “Received.” It should be noted that in some cases application status may not be reflected as such for several days after the submission deadline.

Figure　Application information management (Received)

Q & A

Q&A information can also be found on the following website for research proposal solicitations.
http://www.senryaku.jst.go.jp/teian/top/faq.html

For information on topics like operation of the Cross-ministerial R&D Management System (e-Rad), registering research institutions and researchers, and using the e-Rad system, please refer to the following webpage.
http://www.e-rad.go.jp/

Matters related to both CREST and PRESTO

Responding to the Fiscal year 2013 Call for Proposals

Q When submitting a research proposal, is the approval of the institution with which I am affiliated required?

A It is not required. However, if your proposal is selected, a research agreement will have to be signed by both JST and the research institutions with which you are affiliated, so please notify your research institution ahead of time, as necessary.

Overhead Cost (Indirect Cost)

Q Is support for covering overhead cost (indirect cost) paid to all research institutions that sign a research agreement?

A In principle, an amount equal to 30% of research cost (direct cost) is paid to all research institutions that sign a research agreement. This amount is for covering overhead cost (indirect cost).

Q What types of expenditures count as overhead cost (indirect cost)?

A Overhead cost (indirect cost) includes expenditures for improving the research environment of researchers participating in a research project selected under the CREST or PRESTO programs, and moneys used by research institutions to cover expenditures required for enhancing their overall functions. Prime examples of overhead cost (indirect cost) provided in the "Common Policy on Accounting for Indirect Cost covered with Competitive Funding" (Ministerial and Agency Agreement on Competitive Funding Revised March 27, 2009).

1) Management and administrative expenditures
− Provision, maintenance, and use of facilities and equipment
− Administrative expenses

Furnishings, supplies, equipment rental, outside services, personnel expenses, telecommunications and transportation, honorariums, domestic and international travel, meetings, printing, etc.

Other

2) Research expenditures

− Expenditures for goods, etc. used in common

Furnishings, supplies, equipment rental, outside services, telecommunications and transportation, honorariums, domestic and international travel, meetings, printing, newspapers and magazines, utilities

− Expenditures necessary for advancing the research activities related to application of the funded research

Personnel expenses for researchers, research support staff, etc.; furnishings, supplies, equipment rental, outside services, telecommunications and transportation, honorariums, domestic and international travel, meetings, printing, newspapers and magazines, utilities

− Patent-related expenditures

− Expenditures for the provision, maintenance, and operation of research buildings

− Expenditures for the provision, maintenance, and operation of facilities for managing laboratory animals

− Expenditures for the provision, maintenance, and operation of facilities for interaction among researchers

− Expenditures for the provision, maintenance, and operation of facilities

− Expenditures for the provision, maintenance, and operation of networks

− Expenditures for the provision, maintenance, and operation of large-scale computing equipment (including supercomputers)

− Expenditures for the provision, maintenance, and operation of facilities for housing large-scale computing equipment

− Expenditures for the provision, maintenance, and operation of libraries

− Expenditures for the provision, maintenance, and operation of fields (agricultural, etc.)

Other

3) Other expenditures

− Expenditures related to activities for the further development of research results

− Expenditures related to public relations activities

Other

In addition to those examples provided above, other items that are necessary for improving the research and development environment of a researcher who has obtained competitive funding or that are necessary for improving the overall functions of research institutions may also be counted as overhead cost (indirect cost) if the head of the research institution determines that the incursion of such expenditures is necessary. These expenditures, however, do not include those that should be accounted for as direct cost.

Research institutions that receive funds to cover overhead cost (indirect cost) must appropriately manage their overhead cost (indirect cost) and properly retain, for a period of five years following the conclusion of the contract research agreement, receipts and other documentation (*) evidencing the proper use of funds for covering overhead cost (indirect cost). Furthermore, the head of a research institution that has received funds to cover overhead cost (indirect cost) must report, on the designated form, each fiscal year's overhead cost (indirect cost) expenditures by June 30 of the following fiscal year.

(*) As documentary evidence, documentation that incorporates overhead cost (indirect cost) covered by other public research funds may also be used (It is not necessary to employ segment accounting to reflect multiple research agreements.)

For more details, refer to the directions separately established by JST for executing contract research agreements.

Research Facilities

Q What criteria will be used to determine whether the performance of research would be impractical if not done at a foreign institution?

A Examples of standards that it is anticipated will be used for determining whether research must be performed overseas include the following.

1. Required facilities did not exist in Japan and have been installed only at a foreign institution.
2. Field studies that can be performed only overseas are required.
3. Research materials can be obtained only at a foreign research institution or foreign location, and cannot be brought to Japan.

Personnel Transfers following Proposal Selection

Q If a Research Director (CREST) or researcher (PRESTO) experiences a change of position (promotion, transfer to a different research institution, etc.) while conducting research, will the Research Director (CREST) or researcher (PRESTO) be permitted to continue research activities?

A As long as it is possible to continue research activities unhindered following the change of position, research activities may be continued. Having another person take over as Research Director(CREST) or researcher (PRESTO) as a result of a change of position, however, is not permitted.

Q If a research institution affiliation changes because of the personnel transfer, or other reason, as research is being conducted, is it possible to move research equipment, etc. purchased with research funds to the new research institution?

A Equipment, etc. purchased with research funds can be moved. Equipment, etc. purchased with funds accounted for as research costs (direct cost) must, in principle, be moved, via transfer of ownership, etc. to the new research institution.

Other

Q Who is the Program Officer (PO) for the program? What roles does the PO perform?

A For the CREST and PRESTO programs, the Research Supervisor is the Program Officer (PO) designated for competitive funding systems. For information on the roles played by the Research Supervisor, refer to “2.1.1 CREST Overview” and “3.1.1 PRESTO Overview”.

Q Please provide information on the research topics selected and applications submitted for the previous fiscal year.

A Refer to the JST website (http://www.jst.go.jp/pr/info/info906/index.html).

Q What is the researcher number referred to in Form 1?

A For researchers with a Scientific Research Grant Recipient Number, "researcher number" this refers to that number. For researchers who do not have a Scientific Research Grant Recipient Number, "researcher number" refers to the 8-digit researcher number assigned when researcher information was registered on the e-Rad (Cross-ministerial R&D Management System〔http://www.e-rad.go.jp/〕) system. Research proposals must be submitted via the e-Rad system, so regardless of whether the researcher has a Scientific Research Grant Recipient Number, the researcher's information must be registered on the e-Rad system before the e-Rad system can be used. Researchers who do not have an e-Rad login ID should contact either the responsible party at the research institution with which they are affiliated, or the e-Rad helpdesk. Please note that the registration process can require several days and it is advisable to set aside over two weeks for completing it.

Q At present, I am affiliated with an overseas research institution and do not have a researcher number. What should I do?

A Personally apply for a researcher registration by mailing (postal mail) a completed Researcher Number Issuance Request Form, identification documentation, and other materials directly to the e-Rad system administrator. For more details, go to the e-Rad portal site, click on “For Researchers,” “Preparations for Using the System,” and “Researchers Not Affiliated with a Research Institution” and read the information provided.

Q If the date of the interview conducted as part of the selection process is inconvenient, is it possible to have someone else be interviewed in my place. Alternatively, is it possible to set a different interview date?

A It is not possible to have someone else interviewed in your place. In addition, since, interview dates were set by coordinating the schedules of numerous evaluators, setting a different interview date is also not possible. Please check the interview period information shown in “1.3 Solicitation and Selection Schedule”. Interview schedules for individual research areas will be posted on the call-for-proposals website (http://www.senryaku.jst.go.jp/teian.html), so refer to it, as well.

Matters regarding CREST

Entering Research Costs in Proposals

Q Is it necessary to include in the research proposal: 1) The bases for recording research costs and 2) Yearly budgets?

A It is not necessary to include the bases for recording research costs, but do include an itemized research budget and the research budget for the entire research group in Research Proposal (Form 6). In addition, those selected for participation in the interview phase of the selection process will be asked to prepare supplementary materials covering matters like details of research expenditures.

Research Organization and Budget Allocation

Q Please give examples of joint research group organizational approaches and joint research group budget allocations that are unacceptable.

A Unacceptable organizational approaches include (but are not limited to) ones in which: 1) The Research Directors does not play the central role in the research organization for pursuing the proposed research initiative; 2) A substantial portion of the research is subcontracted to an external party or parties; 3) The role and position of the Joint Research Group relative to the research initiative is unclear; and 3) The budget is allocated equally to the Joint Research Group without considering its role and position.

Q In the interview, is it possible to change the research project organization and total budget, which were included in the research proposal?

A Selections are based on the contents of research proposals, so please be very careful to create a research proposal that you will not want to change later. It should be noted, though, that at the time selections are to be made, changes can be requested in accordance with instructions from the Research Supervisor.

Applicant Requirements

Q Is it possible for non-full-time researchers (guest researchers, etc.) to submit research proposals? Also, is it possible for researchers scheduled to retire during the research period to submit proposals?

A Both are possible if you can establish your own research project organization at a domestic (located in Japan) research institution during the research period and it is possible for JST to enter into a contract research agreement with the research institution.

Research Team Organization

Q　In submitting a CREST research proposal, is it possible to include in the research project organization – as a Lead Joint Researcher – a researcher who is currently performing PRESTO research?

A　It is not possible for a researcher currently performing PRESTO research to participate as a CREST Lead Joint Researcher (excluding projects ending in fiscal year 2013).

Research Cost

Q　In entering the "Total Research Cost” (CREST Form 1) and "Research Budget” (CREST Form 8) in the research proposal, should the amount include overhead cost (indirect cost) to be paid to the research institution if a contract research agreement is signed?

A　Do not include overhead cost (indirect cost). Enter only direct cost information.

Q　After a research proposal is selected, how should the allocation of research expenditures within the team be decided?

A　Once a research proposal is selected, allocations of research expenditures within the team are determined based on the research plan prepared for every fiscal year. For more information on research plans, please refer to "2.3.1 Preparing a Research Plan" .

Q　Please explain the policy objective underlying RAs (Research Assistants).

A　Based on the following policy objectives, CREST recommends that RAs be paid salaries approximating living costs.

(1) 4th Science and Technology Basic Plan (August 19, 2011 Cabinet Decision)

The government will increase grant-type economic support, such as fellowships, Teaching Assistants (TA) and Research Assistants (RA), so that quality students may feel secure about proceeding to a graduate school. With this effort, the government will strive to achieve the goal set by the 3rd Basic Plan, i.e., "enabling 20 percent of doctorate course students to receive an amount equivalent to their living expenses." (Excerpted from P32, 33)

http://www8.cao.go.jp/cstp/kihonkeikaku/4honbun.pdf

(2) On the Expansion of Competitive Funding and Promotion of System Performs (June 14, 2007, Council for Science and Technology Policy)　To secure outstanding researchers, support will be provided to graduate students in the form of enhanced fellowships for students in the latter stages of doctoral programs and enhanced compensation for RAs (Research Assistants) and others, via competitive funding. These and other measures are intended to help achieve the 3rd Science and Technology Basic Plan objective of providing support to approximately 20% of doctoral students in the latter stages of their programs.

http://www8.cao.go.jp/cstp/siryo/haihu68/siryo2-2.pdf

(3) Important issues in the 2008 Science and Technology Basic Policy (January 30 2008 Council for Science and Technology Policy)

Expand investment in the next generation of researcher human resources through measures like enhancement of competitive funding for young researchers and expansion of support for students in doctoral programs. (Excerpted from p5)

http://www8.cao.go.jp/cstp/siryo/haihu73/siryo1.pdf

Use of Research Budgets

Q Is it possible to subcontract program preparation and other such work to external companies, etc.?

A If it is required as a matter of advancing research work, it is possible. However, there is a premise that such subcontracting of work to outside parties is based on subcontracting agreements that exclude research and development work. In principle, the subcontracting of research and development work is not permitted.

Research agreement

Q Is the research agreement entered into by the research institutions with which Lead Joint Researchers are affiliated a subcontract[*1] via the research institution with which the Research Director is affiliated?

A In this program, research agreements are not subcontracts. JST contracts separately with each of the research institutions with which the Research Director and Lead Joint Researchers are affiliated.

Research Evaluations

Q How is research evaluated and how will evaluations be used?

A In principle, CREST research projects undergo an:

1) Interim evaluation around three years after they begin, and a

2) Final evaluation at the end of the research period.

For more information, please refer to “2.3.6 Research Project Evaluations”. In addition, research areas are evaluated (“2.3.7 Research Area Evaluations” and follow-up evaluations take place after a certain amount of time has passed following the completion of the research period. All evaluation results are posted on the website.

Multiple Applications

Q Is it possible to make a CREST research proposal as a Research Director and participate in another research proposal as a Lead Joint Researcher?

A This is possible, but if both proposals come to be considered seriously for selection, research funding may be lowered or the researcher in question may be asked to participate in only one of the research projects, depending on factors like the details and scale of the research to be performed. It should be noted that having researchers swap roles as Research Director and Lead Joint Researcher and submitting multiple research proposals is not permitted. For more details, please refer to "Chapter 7 Restrictions on Multiple Applications to JST Programs”.

Matters regarding PRESTO

Requirements for applicants

Q What is the status with regard to research proposal submissions by female researchers?

A Female researchers comprise 10-20% of those applicants and selectees. In the hope of encouraging research proposal submissions from a broad spectrum of researchers, JST does not consider factors such as gender or research history in making its selections. A special webpage has been created on PRESTO female researchers and it includes application and selection data.

http://www.jst.go.jp/kisoken/presto/nadeshiko/

JST strives to use role models to promote the attractiveness of the scientific and engineering professions, for both men and women, to children, young adults, and people with some connection to science and technology. It is our hope that many of these people will then be encouraged to pursue careers in science and engineering. That is why we conduct our activities in a manner open to both men and women. (http://www.jst.go.jp/gender/)

Q Does the PRESTO program have an age limit?

A There is no particular age limit for submitting PRESTO research proposals. However, research is performed mainly by researchers in their 30s and it is hoped that PRESTO can help to boost the careers of such researchers.

Q Is it possible for non-full-time researchers (guest researchers, etc.) to submit research proposals?

A The PRESTO program has no restrictions in terms of the institutional affiliations or positions of applicants. Whether an applicant is a full-time employee of a research institution or not, or paid or not, is not considered in the selection process.

Q Is it possible to submit a PRESTO research proposal and participate as a Lead Joint Researcher in a CREST research project?

A It is possible to submit a PRESTO research proposal. However, if the subject researcher is already participating as a Lead Joint Researcher in a CREST research project and his/her PRESTO research proposal comes under serious consideration for selection, or if both the subject researcher's PRESTO research proposal and a CREST research proposal for which the researcher would be a Lead Joint Researcher come under serious consideration for selection, adjustments – such as choosing either participation in the CREST research project or pursuing the PRESTO research project – would become necessary (excluding projects ending in fiscal year 2013). It is advisable, therefore, to consult well with the person who is or would be the CREST Research

Director before submitting a PRESTO research proposal.

Q Can a Special Researcher at the Japan Society for the Promotion of Science apply to the PRESTO program?

A There are no restrictions on the applicant's position at the time of application. Researchers who are currently performing work under the system of an institution other than JST, or who will apply to do so, should ask that institution whether it is appropriate to perform work concurrently under its system and the PRESTO program.

Q The discussion in “3.2.4 Research Proposal Submission Requirements” says that, “For proposals to perform research work at an overseas research institution, it must be possible for the subject research institution to enter into a joint research agreement with JST.”

What are the terms and conditions of the agreement that must be signed?

A Download a draft of JST’s designated joint research agreement (http://www.sakigake.jst.go.jp/contract/DraftPRESTO2011e.doc) and then have a person in charge of contracts at the research institution with which you are affiliated examine it to determine whether there are any points that may pose problems. Particular attention should be paid to the three points below.

1. Payments to a foreign research institution to cover overhead cost (indirect cost) shall not exceed 30% of direct cost (research cost).
2. Intellectual property assets can be shared by the overseas research institution and JST, with 50% shares held by each.
3. It must be possible to submit to JST English-language cost statements showing the details of research expenditures (equivalent to the account books used by Japanese institutions).

Research Period

Q Are there any calls for proposals for five-year research projects?

A For the current fiscal year, there are no calls for proposals for five-year research projects. As for the next and later fiscal years, please refer to the call for proposal descriptions for each fiscal year.

Research Cost

Q Is it necessary to include in the research proposal: 1) The bases for recording research costs and 2) Yearly budgets?

A It is not necessary. However, those selected for participation in the interview phase of the selection process will be asked to prepare supplementary materials covering matters like details of research expenditures.

Joint and Exclusive Appointments

Q What are the conditions for a researcher to receive a joint appointment?

A A joint appointment can be received if the researcher's research institution approves the researcher's request for a joint appointment. Regarding matters like time spent on joint appointments, please follow the research institution's provisions.

Use of Research Budgets

Q Is it possible to subcontract program preparation and other such work to external companies, etc.?

A If it is required as a matter of advancing research work, it is possible. However, there is a premise that such subcontracting of work to outside parties is based on subcontracting agreements that exclude research and development work.

Employment of Researchers with Doctoral Degrees

Q Under the PRESTO program, is it possible to employ a researcher who has a doctoral degree (a postdoc)?

A Under the PRESTO program, it is not possible to create a research team including postdocs. However, postdocs can be employed as research assistants to support the efforts of an individual researcher pursuing PRESTO research.

Other

Q Is it possible to suspend and later resume PRESTO research in response to life events (childbirth, child care, and nursing care)?

A If a PRESTO researcher experiences of a life event during the research period, it is possible, upon consultation with the Research Supervisor, to suspend research work for periods of time designated for individual life events and later resume work.

Appendix

List of Categories, Areas, Disciplines and Research Fields

Category: Integrated Disciplines			
Area	Discipline	Research Field	Item Number
Informatics	Principles of Informatics	Theory of informatics	1001
		Mathematical informatics	1002
		Statistical science	1003
	Principles of Informatics	Computer system	1101
		Software	1102
		Information network	1103
		Multimedia database	1104
		High performance computing	1105
		Information security	1106
	Human informatics	Cognitive science	1201
		Perceptual information processing	1202
		Human interface and interaction	1203
		Intelligent informatics	1204
		Soft computing	1205
		Intelligent robotics	1206
		Kansei informatics	1207
	Frontiers of informatics	Life / Health / Medical informatics	1301
		Web informatics, Service informatics	1302
		Library and information science/ Humanistic social informatics	1303
		Learning support system	1304
		Entertainment and game informatics	1305
Environmental science	Environmental analyses and evaluation	Environmental dynamic analysis	1401
		Risk sciences of radiation and chemicals	1402
		Environmental impact assessment	1403
	Environmental conservation	Environmental engineering and reduction of environmental burden	1501
		Modeling and technologies for environmental conservation and remediation	1502
		Environmental conscious materials and recycle	1503
		Environmental risk control and evaluation	1504
	Sustainable and environmental system development	Environmental and ecological symbiosis	1601
		Design and evaluation of sustainable and environmental conscious system	1602
		Environmental policy and social systems	1603
Complex systems	Design science	Design science	1651
	Human life science	Home economics/Human life	1701
		Clothing life/Dwelling life	1702
		Eating habits	1703
	Science education/Educational technology	Science education	1801
		Educational technology	1802
	Sociology/History of science and technology	Sociology/History of science and technology	1901
	Cultural assets study and museology	Cultural assets study and museology	2001
	Geography	Geography	2101
	Social/Safety system science	Social systems engineering/Safety system	2201
		Natural disaster / Disaster prevention science	2202
	Biomedical engineering	Biomedical engineering/ Biomaterial science and engineering	2301
		Medical systems	2302
		Medical engineering assessment	2303
		Rehabilitation science/Welfare engineering	2304
	Health/Sports science	Developmental mechanisms and the body works	2401
		Sports science	2402
		Applied health science	2403
	Childhood science	Childhood science (childhood environment science)	2451
	Biomolecular science	Biomolecular chemistry	2501
		Chemical biology	2502
	Brain sciences	Basic / Social brain science	2601
		Brain biometrics	2602

Category: Humanities and Social Sciences			
Area	Discipline	Research Field	Item Number
Humanities/ Social sciences	Area studies	Area studies	2701
	Gender	Gender	2801
Humanities	Philosophy	Philosophy/Ethics	2901
		Chinese philosophy/Indian philosophy/Buddhist studies	2902
		Religious studies	2903
		History of thought	2904
	Art studies	Aesthetics and studies on art	3001
		Fine art history	3002
		Art at large	3003
	Literature	Japanese literature	3101
		Literature in English	3102
		European literature	3103
		Chinese literature	3104
		Literature in general	3105
	Linguistics	Linguistics	3201
		Japanese linguistics	3202
		English linguistics	3203
		Japanese language education	3204
		Foreign language education	3205
	History	Historical studies in general	3301
		Japanese history	3302
		History of Asia and Africa	3303
		History of Europe and America	3304
		Archaeology	3305
	Human geography	Human geography	3401
	Cultural anthropology	Cultural anthropology	3501
Social sciences	law	Fundamental law	3601
		Public law	3602
		International law	3603
		Social law	3604
		Criminal law	3605
		Civil law	3606
		New fields of law	3607
	Politics	Politics	3701
		International relations	3702
	Economics	Economic theory	3801
		Economic doctrine/ Economic thought	3802
		Economic statistics	3803
		Economic policy	3804
		Public finance/Public economy	3805
		Money/ Finance	3806
		Economic history	3807
	Management	Management	3901
		Commerce	3902
		Accounting	3903
	Sociology	Sociology	4001
		Social welfare and social work studies	4002
	Psychology	Social psychology	4101
		Educational psychology	4102
		Clinical psychology	4103
		Experimental psychology	4104
	Education	Education	4201
		Sociology of education	4202
		Education on school subjects and activities	4203
		Special needs education	4204

Category: Science and Engineering			
Area	Discipline	Research Field	Item Number
Interdisciplinary science and engineering	Nano/Micro science	Nanostructural chemistry	4301
		Nanostructural physics	4302
		Nanomaterials chemistry	4303
		Nanomaterials engineering	4304
		Nanobioscience	4305
		Nano/Microsystems	4306
	Applied physics	Applied materials	4401
		Crystal engineering	4402
		Thin film/Surface and interfacial physical properties	4403
		Optical engineering, Photon science	4404
		Plasma electronics	4405
		General applied physics	4406
	Quantum beam science	Quantum beam science	4501
	Computational science	Computational science	4601
Mathematical and physical sciences	Mathematics	Algebra	4701
		Geometry	4702
		Basic analysis	4703
		Mathematical analysis	4704
		Foundations of mathematics/Applied mathematics	4705
	Astronomy	Astronomy	4801
	Physics	Particle/Nuclear/Cosmic ray/Astro physics	4901
		Condensed matter physics I	4902
		Condensed matter physics II	4903
		Mathematical physics/ Fundamental condensed matter physics	4904
		Atomic/Molecular/Quantum electronics	4905
		Biological physics/Chemical physics/Soft matter physics	4906
	Earth and planetary science	Solid earth and planetary physics	5001
		Meteorology/Physical oceanography/Hydrology	5002
		Space and upper atmospheric physics	5003
		Geology	5004
		Stratigraphy/Paleontology	5005
		Petrology/Mineralogy/ Economic geology	5006
		Geochemistry/Cosmochemistry	5007
	Plasma science	Plasma science	5101
Chemistry	Basic chemistry	Physical chemistry	5201
		Organic chemistry	5202
		Inorganic chemistry	5203
	Applied chemistry	Functional solid state chemistry	5301
		Synthetic chemistry	5302
		Polymer chemistry	5303
		Analytical chemistry	5304
		Bio-related chemistry	5305
		Green/Environmental chemistry	5306
		Energy-related chemistry	5307
	Materialschemistry	Organic and hybrid materials	5401
		Polymer/Textile materials	5402
		Inorganic industrial materials	5403
		Device related chemistry	5404
Engineering	Mechanical engineering	Materials/ Mechanics of materials	5501
		Production engineering/ Processing studies	5502
		Design engineering/ Machine functional elements/ Tribology	5503
		Fluid engineering	5504
		Thermal engineering	5505
		Dynamics/Control	5506
		Intelligent mechanics/ Mechanical systems	5507
	Electrical and electronic engineering	Power engineering/Power conversion/Electric machinery	5601
		Electronic materials/ Electric materials	5602
		Electron device/ Electronic equipment	56003
		Communication/ Network engineering	5604
		Measurement engineering	5605
		Control engineering/System engineering	5606
	Civil engineering	Civil engineering materials/ Construction/ Construction management	5701
		Structural engineering/ Earthquake engineering/ Maintenance management engineering	5702
		Geotechnical engineering	5703
		Hydraulic engineering	5704
		Civil engineering project/ Traffic engineering	5705
		Civil and environmental engineering	5706
	Architecture and building engineering	Building structures/Materials	5801
		Architectural environment/ Equipment	5802
		Town planning/ Architectural planning	5803
		Architectural history/Design	5804

Category: Science and Engineering			
Area	Discipline	Research Field	Item Number
Engineering	Material engineering	Physical properties of metals/Metal-base materials	5901
		Inorganic materials/Physical properties	5902
		Composite materials/Surface and interface engineering	5903
		Structural/Functional materials	5904
		Material processing/Microstructural control engineering	5905
		Metal making/ Resource Metal making/ Resource	5906
	Process/Chemical engineering	Properties in chemical engineering process/Transfer operation/Unit operation	6001
		Reaction engineering/Process system	6002
		Catalyst/Resource chemical process	6003
		Biofunction/Bioprocess	6004
	Integrated engineering	Aerospace engineering	6005
		Naval and maritime engineering	6101
		Earth system and resources engineering	6102
		Nuclear fusion studies	6103
		Nuclear engineering	6104
		Energy engineering	6105

Category: Biological Sciences			
Area	Discipline	Research Field	Item Number
Biological Sciences	Neuroscience	Neurophysiology / General neuroscience	6201
		Nerve anatomy/Neuropathology	6202
		Neurochemistry/Neuropharmacology	6203
	Laboratory animal science	Laboratory animal science	6301
	Oncology	Tumor biology	6401
		Tumor diagnostics	6402
		Tumor therapeutics	6403
	Genome science	Genome biology	6501
		Medical genome science	6502
		System genome science	6503
	Conservation of biological resources	Conservation of biological resources	6601
Biology	Biological Science	Molecular biology	6701
		Structural biochemistry	6702
		Functional biochemistry	6703
		Biophysics	6704
		Cell biology	6705
		Developmental biology	6706
	Basic biology	Plant molecular biology/Plant physiology	6801
		Morphology/Structure	6802
		Animal physiology/Animal behavior	6803
		Genetics/Chromosome dynamics	6804
		Evolutionary biology	6805
		Biodiversity/Systematics	6806
		Ecology/Environment	6807
	Anthropology	Physical anthropology	6901
		Applied anthropology	6902
Agricultural sciences	Plant production and environmental agriculture	Science in genetics and breeding	7001
		Crop production science	7002
		Horticultural science	7003
		Plant protection science	7004
	Agricultural chemistry	Plant nutrition/Soil science	7101
		Applied microbiology	7102
		Applied biochemistry	7103
		Bioorganic chemistry	7104
		Food science	7105
	Forest and forest products science	Forest science	7201
		Wood science	7202
	Applied aquatic science	Aquatic bioproduction science	7301
		Aquatic life science	7302
	Agricultural science in society and economy	Agricultural science in management and economy	7401
		Agricultural science in rural society and development	7402
	Agro-engineering	Rural environmental engineering/Planning	7501
		Agricultural environmental engineering/Agricultural information engineering	7502
	Animal life science	Animal production science	7601
		Veterinary medical science	7602
		Integrative animal science	7603
	Boundary agriculture	Insect science	7701
		Environmental agriculture(including landscape science)	7702
		Applied molecular and cellular biology	7703

Category: Biological Sciences			
Area	Discipline	Research Field	Item Number
Medicine, dentistry, and pharmacy	Pharmacy	Chemical pharmacy	7801
		Physical pharmacy	7802
		Biological pharmacy	7803
		Pharmacology in pharmacy	7804
		Natural medicines	7805
		Drug development chemistry	7806
		Environmental and hygienic pharmacy	7807
		Medical pharmacy	7808
	Basic medicine	General anatomy (including histology/embryology)	7901
		General physiology	7902
		Environmental physiology (including physical medicine and nutritional physiology)	7903
		General pharmacology	7904
		General medical chemistry	7905
		Pathological medical chemistry	7906
		Human genetics	7907
		Human pathology	7908
		Experimental pathology	7909
		Parasitology (including sanitary zoology)	7910
		Bacteriology (including mycology)	7911
		Virology	7912
		Immunology	7913
		Medical sociology	8001
	Boundary medicine	Applied pharmacology	8002
		Laboratory medicine	8003
		Pain science	8004
		Epidemiology and preventive medicine	8101
	Society medicine	Hygiene and public health	8102
		Medical and hospital management	8103
		Legal medicine	8104
		General internal medicine	8201
	Clinical internal medicine	Gastroenterology	8202
		Cardiovascular medicine	8203
		Respiratory organ internal medicine	8204
		Kidney internal medicine	8205
		Neurology	8206
		Metabolomics	8207
		Endocrinology	8208
		Hematology	8209
		Collagenous pathology/Allergology	8210
		Infectious disease medicine	8211
		Pediatrics	8212
		Embryonic/Neonatal medicine	8213
		Dermatology	8214
		Psychiatric science	8215
		Radiation science	8216
		General surgery	8301
	Clinical surgery	Digestive surgery	8302
		Cardiovascular surgery	8303
		Respiratory surgery	8304
		Neurosurgery	8305
		Orthopaedic surgery	8306
		Anesthesiology	8307
		Urology	8308
		Obstetrics and gynecology	8309
		Otorhinolaryngology	8310
		Ophthalmology	8311
		Pediatric surgery	8312
		Plastic surgery	8313
		Emergency medicine	8314
		Morphological basic dentistry	8401
	Dentistry	Functional basic dentistry	8402
		Pathobiological dentistry/ Dental radiology	8403
		Conservative dentistry	8404
		Prosthodontics/ Dental materials science and engineering	8405
		Dental engineering/ Regenerative dentistry	8406
		Surgical dentistry	8407
		Orthodontics/Pediatric dentistry	8408
		Periodontology	8409
		Social dentistry	8410
		Fundamental nursing	8501
	Nursing	Clinical nursing	8502
		Lifelong developmental nursing	8503
		Gerontological nursing	8504
		Community health nursing	8505

[Inquiry Counter]

Inquiries made by e-mail are preferable, except for urgent situations. Schedules and important updates regarding the Invitation for Application of Research Proposals will be announced on the website for Application of Research Proposals.

http://www.senryaku.jst.go.jp/teian-en.html

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