PRESTO '14

Precursory Research for Embryonic Science and Technology

Strategic Basic Research Programs

http://www.jst.go.jp/en

独立行政法人 科学技術振興機構
Japan Science and Technology Agency

What is PRESTO?

Concept

PRESTO (Precursory Research for Embryonic Science and Technology) is a program that supports research projects conducted by individual researchers, intended for fostering promising ideas for future innovation that fit the Strategic Objectives. The three- to five-year projects, managed by Research Supervisors and assisted by Research Area Advisors, provide participants with opportunities of contact with colleagues who share the research interest through research meetings held twice a year. The program has given birth to a number of human networks for innovation.

Outline

Research Period
The research period is up to 3 years or 5 years.

Research Expenditures
Generally, research expenditures per research theme are approximately between 30 million and 40 million yen for 3-year themes, and between 50 million and 100 million yen for 5-year themes.

Participation
Researchers selected for this program will belong to JST as part-time or full-time researchers.

1. Envisioned part-time researchers
   - Researchers who belong to universities
   - Researchers who belong to independent administrative institutions
   - Researchers who belong to national and public institutes
   - Researchers who belong to research institutions which are juridical foundations.
2. Envisioned full-time researchers
   - Postdoctoral fellows
   - Researchers who are retiring from their current institution.

Research Site
In principle, researchers should conduct their research in their current research site. By concluding research agreements, researchers can conduct research at the institution they belong to.

Research Agreement
JST concludes commissioned or joint research agreement with the research institution where the researcher conducts the research.

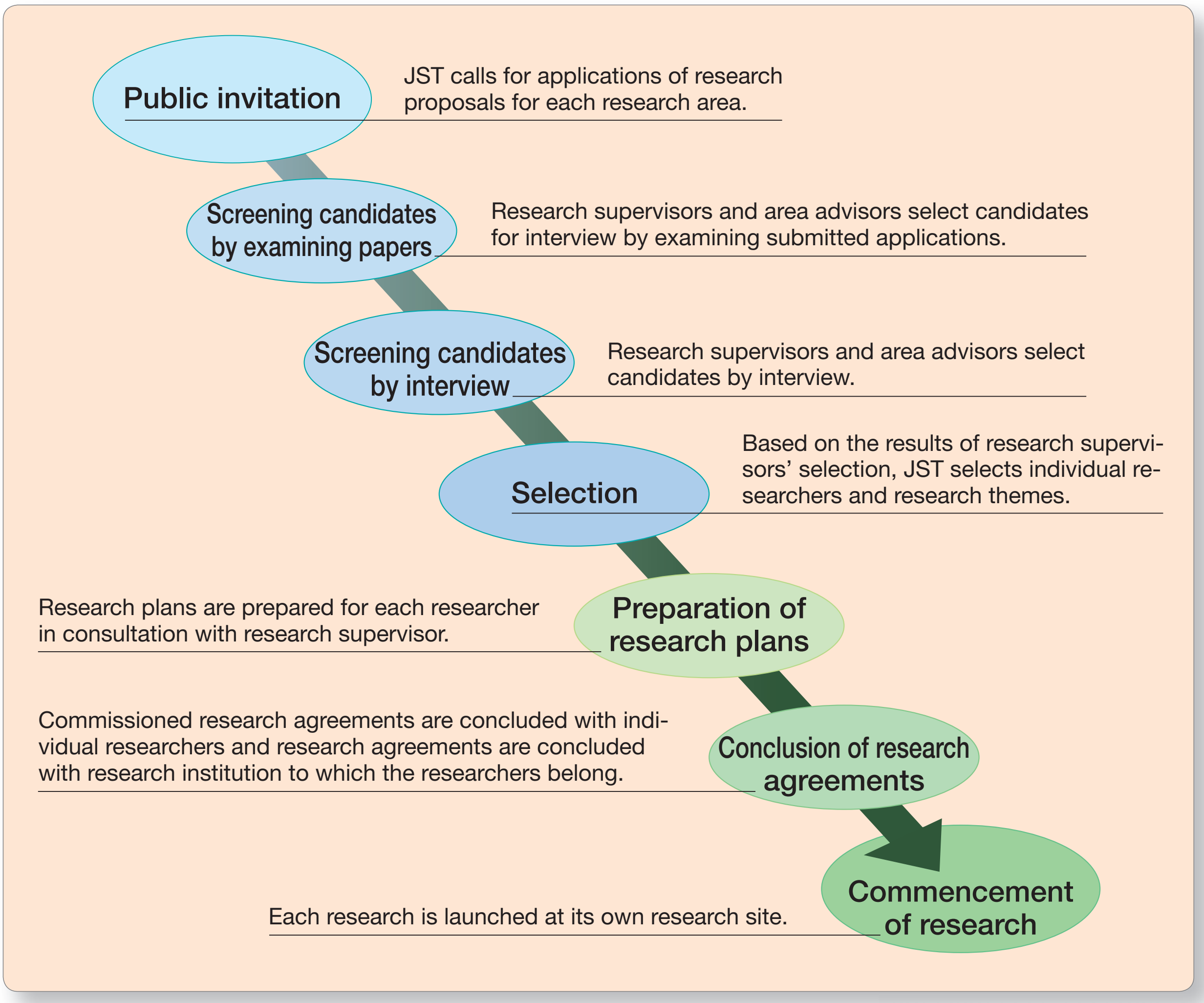
Research Meeting
JST holds closed meetings conducted by the Research Supervisors twice a year to discuss the research plan, to report progress or to promote communication among researchers in the Research Area.

Intellectual Property Rights
Intellectual property rights arising from research based on commissioned research agreements basically belong to the research institutes.

Research Results and Evaluation
Researchers are actively encouraged to present research results both inside and outside Japan. When the research period ends, researchers should report the research results in a symposium which is open to the public. When the research is complete, a post-evaluation is made and, when needs arise, a follow-up evaluation is conducted. The results of, and evaluations on, the research projects will be made public.

From Public Invitation of Research Proposals to Commencement of Research

Detailed information about how to make research proposals can be found at the relevant submission-related pages on our website. The webpage addresses, together with a general overview and information about application acceptance periods, are available at http://www.jst.go.jp/ and are also published in newspaper announcements and included in our magazine mailings.



PRESTO URL **http://www.jst.go.jp/kisoken/presto/en/**

Introduction of Research Area

On-going Research

27 Research Areas, 692 Research Themes

	Research Area	Research Supervisor
	Creation of Innovative Core Technology for Manufacture and Use of Energy Carriers from Renewable Energy	**Koichi Eguchi** (Professor, Graduate School of Engineering, Kyoto University)
	Phase Interfaces for Highly Efficient Energy Utilization	**Nobuhide Kasagi** (Professor Emeritus, The University of Tokyo)
	Creation of Essential Technologies to Utilize Carbon Dioxide as a Resource through the Enhancement of Plant Productivity and the Exploitation of Plant Products	**Akira Isogai** (Professor Emeritus, Nara Institute of Science and Technology)
	Creation of Basic Technology for Improved Bioenergy Production through Functional Analysis and Regulation of Algae and Other Aquatic Microorganisms	**Tadashi Matsunaga** (President, Tokyo University of Agriculture and Technology)
	Photoenergy Conversion Systems and Materials for the Next Generation Solar Cells	**Shuzi Hayase** (Professor, Kyushu Institute of Technology)
	Chemical Conversion of Light Energy	**Haruo Inoue** (Executive Director / Professor, Center for Artificial Photosynthesis, Tokyo Metropolitan University)
	Innovative Technology Platforms for Integrated Single Cell Analysis	**Itaru Hamachi** (Professor, Graduate School of Engineering, Kyoto University)
	Creation of Innovative Technology for Medical Applications Based on the Global Analyses and Regulation of Disease-Related Metabolites	**Yoshiya Oda** (President, Biomarkers and Personalized Medicine Core Function Unit, Eisai Product Creation Systems)
	Elucidation and Regulation in the Dynamic Maintenance and Transfiguration of Homeostasis in Living Body	**Masato Kasuga** (President, National Center for Global Health and Medicine)
	Structural Life Science and Advanced Core Technologies for Innovative Life Science Research	**Soichi Wakatsuki** (Professor, SLAC National Acceletator Laboratory / Stanford University)
	Design and Control of Cellular Functions	**Hiroki Ueda** (Professor, Graduate School of Medicine and Faculty of Medicine, The University of Tokyo)
	Elucidation and Control of the Mechanisms Underlying Chronic Inflammation	**Kiyoshi Takatsu** (Director, Toyama Prefectural Institute of Pharmaceutical Research)
	Development and Function of Neural Networks	**Fujio Murakami** (Specially Appointed Professor, Osaka University)
	Epigenetic Control and Biological Functions	**Tsunehiro Mukai** (Professor Emeritus, Saga University)
	Understanding Life by iPS Cells Technology	**Shin-ichi Nishikawa** (Advisor, JT Biohistory Research Hall / President, All About Science Japan)
	Decoding and Controlling Brain Information	**Mitsuo Kawato** (Director, ATR Fellow, ATR Brain Information Communication Research Laboratory Group)
	Innovative Nano-Electronics through Interdisciplinary Collaboration among Material, Device and System Layers	**Takayasu Sakurai** (Professor, Institute of Industrial Science, The University of Tokyo) **Naoki Yokoyama** 【Deputy Research Supervisor】 (Fellow, FUJITSU LABORATORIES LTD.)
	Hyper-Nano-Space Design toward Innovative Functionality	**Kazuyuki Kuroda** (Professor, Faculty of Science and Engineering, Waseda University)
	Molecular Technology and Creation of New Functions	**Takashi Kato** (Professor, School of Engineering, The University of Tokyo)
	New Materials Science and Element Strategy	**Hideo Hosono** (Professor, Tokyo Institute of Technology)
	Innovative Use of Light and Materials/Life	**Hiroshi Masuhara** (Chair Professor, National Chiao Tung University)
	Nanosystems and Emergent Functions	**Yoshihito Osada** (Group Director, Advanced Science Institute, RIKEN)
	Collaborative Mathematics for Real World Issues	**Hiroshi Kokubu** (Professor, Graduate School of Science, Kyoto University)
	Design of Information Infrastructure Technologies Harmonized with Societies	**Hiroto Yasuura** (Executive Vice President / Professor, Graduate School of Science, Kyushu University)
	Advanced Core Technologies for Big Data Integration	**Masaru Kitsuregawa** (Director General, National Institute of Informatics) **Etsuya Shibayama** 【Deputy Research Supervisor】 (Professor, The University of Tokyo)
	Information Environment and Humans	**Toru Ishida** (Professor, Kyoto University)
	Synthesis of Knowledge for Information Oriented Society	**Hideyuki Nakashima** (President, Future University-Hakodate)

	Strategic Objective	First Year	Call for Proposals	Themes	Page Number
	Creation of core technologies for innovative energy carrier utilization aimed at the transport, storage, and use of renewable energy	FY 2013	open	4	P. 4
	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	FY 2011	-	32	P. 4
	Creation of basic technologies for utilizing plant photosynthetic functions and biomass that will enable the actualization of efficient carbon dioxide utilization	FY 2011	-	31	P. 4
	Establishment of basic technologies to create bioenergy from algae and other aquatic microorganisms, including growth rate control and metabolic network construction based on genome analysis and function modification	FY 2010	-	28	P. 5
	Creation of natural light energy conversion material and utilization basic technology through the fusion of different fields	FY 2009	-	36	P. 5
		FY 2009	-	39	P. 5
	Creation of integrated single cell analysis fundamental technology contribute to the elucidation of biological functions	FY 2014	open	-	P. 6
	Creation of core technologies for early-stage drug discovery through the investigation of disease-specific profiles of biomolecules	FY 2013	-	7	P. 6
	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	FY 2012	open	26	P. 6
	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	FY 2012	open	23	P. 7
	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	FY 2011	-	39	P. 7
	Creation of basic medical technologies for the prevention, diagnosis and treatment of cancer, arteriosclerotic diseases, and autoimmune disorders by the elucidation of the mechanisms underlying chronic inflammation	FY 2010	-	37	P. 7
	Clarification of the control mechanisms of neural circuit operation and its formation	FY 2009	-	45	P. 8
	Creation of innovative basic medical technologies by stem cell manufacturing and control based on cell reprogramming	FY 2009	-	40	P. 8
		FY 2008	-	30	P. 8
	Creation of innovative fundamental technologies for utilizing information related to action and judgment in the brain	FY 2008	-	37	P. 9
	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	FY 2013	open	13	P. 9
	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.	FY 2013	open	11	P. 9
	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	open	28	P. 10
	Creation of innovative function of materials by application of nanoscale material structural control technologies such as controlling atomic arrangement, towards practical use of rare-metal-free materials and new targeted functions such as ultra-high coercivity and ultra-high fracture toughness	FY 2010	-	34	P. 10
	Enhancing advanced materials science and life science toward innovations using new light sources, including state-of-the-art laser technology	FY 2008	-	40	P. 10
	Creation of next-generation nanosystems through process integration	FY 2008	-	40	P. 11
	Development of mathematical sciences to describe and analyze social issues in which basic principle is unclear 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	FY 2014	open	-	P. 11
	Development of intelligent information processing technology to realize creative collaboration between human and machines 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	FY 2014	open	-	P. 11
	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	FY 2013	open	6	P. 12
	Creation of basic technology that enables an information environment that is in harmony with people	FY 2009	-	36	P. 12
	Creation of fundamental technology for the generation and utilization of "knowledge" from diverse and large-scale information.	FY 2008	-	30	P. 12

Creation of Innovative Core Technology for Manufacture and Use of Energy Carriers from Renewable Energy

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

2013 – 2018

http://www.jst.go.jp/kisoken/presto/en/research_area/ongoing/202ecarrier.html

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.

Phase Interfaces for Highly Efficient Energy Utilization

Research Supervisor
Nobuhide Kasagi
Professor Emeritus, The University of Tokyo

2011 – 2017

http://www.jst.go.jp/kisoken/presto/en/research_area/ongoing/101soukaimen.html

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.

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
Professor Emeritus, Nara Institute of Science and Technology

2011 – 2016

http://www.jst.go.jp/presto/plantsci/en/index.html

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.

Creation of Basic Technology for Improved Bioenergy Production through Functional Analysis and Regulation of Algae and Other Aquatic Microorganisms

Research Supervisor
Tadashi Matsunaga
President, Tokyo University of Agriculture and Technology

2010 – 2015

http://www.jst.go.jp/presto/bioenergy/english/index.html

This research area aims to create new basic technologies for bioenergy production using algae and other aquatic microorganisms. Some algae and other aquatic microorganisms have high lipid or carbohydrate content, produce various hydrocarbons, and show high growth capability. These properties can be applied to innovative technologies for bioenergy production.

Specifically, research proposals should focus on improvements in the efficiency of energy production through the elucidation of the physiological functions and metabolic pathways of algae and other aquatic microorganisms, which are effective bioenergy producers, using advanced scientific technologies from the fields of genomics, proteomics, metabolomics, and cell analysis. Moreover, the results of proposed research may also benefit various other technologies related to the production of useful chemicals and water treatment using algae and other aquatic microorganisms.

Challenging research themes in broad areas including biology, chemistry, and engineering are welcome for the future realization of innovative technologies leading to bioenergy production.

Photoenergy Conversion Systems and Materials for the Next Generation Solar Cells

Research Supervisor
Shuzi Hayase
Professor, Kyushu Institute of Technology

2009 – 2016

http://www.jst.go.jp/presto/solar/en/index.html

This research area will lead to proposals for next generation solar cells. The aim is to build new basic technology for the future practical use of solar cells by promoting the fusion of different areas through the participation of researchers from a wide range of areas, such as chemistry, physics, and electrical engineering.

Specifically, it targets dye-sensitized, organic thin film, and quantum dot type high performance solar cell research, and research on silicon and compound solar cells with approaches that differ from the conventional. At the same time, basic research, such as surface control technology, membrane and crystal growth, development of new materials, new processes, and new device structures that lead to creation of solar cells based on completely new principles, is also included.

With an emphasis on the creation of next generation solar cells, a wide range of research from theoretical studies to process research for practical use is included in this research area.

Chemical Conversion of Light Energy

Research Supervisor
Haruo Inoue
Executive Director / Professor, Center for Artificial Photosynthesis, Tokyo Metropolitan University

2009 – 2016

http://www.chem-conv.jst.go.jp/index.html

The present research area involves innovative and challenging investigations which aim to realize the highly efficient conversion, storage and utilization of light energy into useful and clean chemical energy by harnessing solar light as the ideal energy resource for mankind.

Specifically, this research includes investigations in light-induced hydrogen evolution using semiconductor catalysts and/or metal complexes, the photoreduction of carbon dioxide, highly efficient light harvesting electron transfer charge separation and electron relay systems, design and control of photochemical reaction environments, redox systems involving water molecules, photoelectric conversion incorporating advanced nanotechnologies, technical application of plants, algae, and bacteria with high photosynthetic properties, photo-assisted energy production from biomass, and the elucidation of the mechanisms involved in photosynthesis.

From such diverse fields as photochemistry, organic chemistry, materials science, nanotechnology and biotechnology, this research project explores the development of future energy systems through innovative technologies based on new and original approaches and concepts.

Innovative Technology Platforms for Integrated Single Cell Analysis

Research Supervisor
Itaru Hamachi
Professor, Graduate School of Engineering, Kyoto University

2014 – 2019

http://www.jst.go.jp/kisoken/presto/en/research_area/ongoing/108onecell.html

This Research Area will bring together individual researchers with technological challenges, thereby navigating their challenges towards the establishment of core technologies in next-generation single-cell analysis toolkits.

We would like aim to construct a platform made of fundamental analytical technologies that streamlines data-based single cell phenotyping. This platform is anticipated to realize quantitative, multiplexed analyses of a variety of biomolecules including nucleic acids, proteins, saccharides, lipids etc and the complex interactions at the intracellular and intercellular levels. Obviously, it requires diverse interdisciplinary approaches in nanotechnology, engineering, chemistry, optics, materials science, chemical biology, information science, which should be mixed with the steady progress in traditional biotechnology, on the basis of the deep understanding of real needs in life science communities. Therefore this Research Area welcomes ambitious young individuals to form a multidisciplinary virtual-network institute and nurtures them with its diversity to help them found their own unique technologies.

Open innovation is an integral part of this Research Area. Marketing might be considered even at the early phase in some cases, although too short-sighted project is not supported. Rather, all the PRESTO researchers are required to recognize that matured technologies must be accepted by intended users, and that the long-running development process must involve active, collaborative, and open efforts with both academic and industrial stakeholders at all times. Thus synergistically, this Research Area as a whole is committed to world-leading single cell analysis community with its potential to drive science and technology innovation.

Creation of Innovative Technology for Medical Applications Based on the Global Analyses and Regulation of Disease-Related Metabolites

Research Supervisor
Yoshiya Oda
President, Biomarkers and Personalized Medicine Core Function Unit, Eisai Product Creation Systems

2013 – 2018

http://www.jst.go.jp/kisoken/presto/en/research_area/ongoing/106sikkan.html

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.

Elucidation and Regulation in the Dynamic Maintenance and Transfiguration of Homeostasis in Living Body

Research Supervisor
Masato Kasuga
President, National Center for Global Health and Medicine

2012 – 2017

http://www.jst.go.jp/presto/hody/en/index.html

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.

Structural Life Science and Advanced Core Technologies for Innovative Life Science Research

Research Supervisor

Soichi Wakatsuki

Professor, SLAC National Accelerator Laboratory / Stanford University

2012 – 2017

http://www.jst.go.jp/presto/struct-lifesci/en/index.html

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.

Design and Control of Cellular Functions

Research Supervisor

Hiroki Ueda

Professor, Graduate School of Medicine and Faculty of Medicine, The University of Tokyo

2011 – 2016

http://www.jst.go.jp/presto/synbio/en/

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.

Elucidation and Control of the Mechanisms Underlying Chronic Inflammation

Research Supervisor

Kiyoshi Takatsu

Director, Toyama Prefectural Institute of Pharmaceutical Research

2010 – 2015

http://inflam.jst.go.jp/en/index.html

Inflammation, which forms a part of the complex biological response of vascular tissues to pathogens, damaged cells, or irritants, is a protective response of an organism to remove the injurious stimuli and to initiate the healing process. There are two types of inflammation: acute and chronic. Acute inflammation is the initial response of the body to harmful stimuli. Prolonged inflammation, known as chronic inflammation, is characterized by simultaneous destruction and healing of tissue as a part of the inflammatory process. Abnormalities associated with inflammation, particularly chronic inflammation, comprise a large group of disorders that underlie a vast range of human diseases.

Recent progress in immunology and inflammation research has revealed a molecular basis for inflammation and chronic diseases. However, it remains elusive as to how acute inflammation progresses to chronic inflammation spatiotemporally, and how chronic inflammatory diseases develop in various tissues.

This research area aims to create innovative research to clarify the regulatory mechanisms involved in the pathogenesis of inflammation and chronic diseases. The subject covers areas of exploratory research and development of technologies that are expected to benefit the society and to connect basic inflammatory research to clinical research on chronic disorders. The main objective is to clarify and control chronic inflammation and inflammatory disorders by analyzing not only the pathogenesis and maintenance of chronic inflammation with a spatiotemporal perspective but also the severe progression of diseases with a background of chronic inflammation.

From this perspective, this research area includes various research approaches, such as immunology, microbiology and virology, cell biology, pathology, experimental inflammation and tissue engineering, and clinical medicine.

Development and Function of Neural Networks

Research Supervisor
Fujio Murakami
Specially Appointed Professor, Osaka University

2009 – 2016

http://www.jst.go.jp/presto/neuronet/english/index.html

This research area will include research aimed at comprehensive understanding of how brain works via elucidation of the principles of the formation and functions of neural networks, as well as the control mechanism from a novel viewpoint.

Specifically, this area includes research on the formation of neuronal networks, nuclei and layer structures that constitute the functional units of the brain; regionalization/arealization of the brain and specification of neurons; information processing by a single neuron; communication between neurons and synaptic plasticity; development and plasticity of neural network functions; the principles of information processing by complex network assemblies; and controls mechanisms. This area also includes research on the role of glial cells and other non-neuronal cells as well as the mechanism of maintenance of the number of neurons. The area includes creation of innovative platform technology that contributes to dramatic progress in the elucidation of the formation of neural networks and the principle of information processing.

Epigenetic Control and Biological Functions

Research Supervisor
Tsunehiro Mukai
Professor Emeritus, Saga University

2009 – 2016

http://www.epigenetics.jst.go.jp/index_e.html

This research area includes research to elucidate epigenetic control and biological functions. More specifically, this includes elucidation of the mechanism of epigenetic control, investigation of the association of a variety of biological phenomena and epigenetics, and analysis of the diversity of epigenetics and diseases associated with abnormalities of epigenetics. In the research, the molecular basis of epigenetics as a biological function will be elucidated to create fundamental technologies for advanced medicine through generation and regulation of stem cells, based on cellular reprogramming

Specific research projects may include

(1) multilateral investigation and elucidation of the mechanism of epigenetic control in a variety of model organisms, including animals and plants;
(2) investigation of individual variability and diversity of epigenetics and analysis of diseases caused by epigenetic abnormalities; and
(3) development of technology for analysis and control of epigenetics.

Understanding Life by iPS Cells Technology

Research Supervisor
Shin-ichi Nishikawa
Advisor, JT Biohistory Research Hall / President, All About Science Japan

2008 – 2015

http://www.ips-s.jst.go.jp/index_e.html

This research area comprises several fields (including cellular reprogramming, transdifferentiation and stem cell biology) in which major breakthroughs are expected by use of the technology involved in establishing induced pluripotent stem (iPS) cells. Basic research using pioneering new approaches or having the potential for clinical medicine will be also involved.

Specifically included are

1) advancing and simplifying reprogramming technologies based on the molecular biological mechanisms of reprogramming,
2) analysis and artificial regulation of stem cell transdifferentiation processes,
3) elucidation of the molecular mechanisms underlying epigenetic alteration during iPS formation
4) elucidation of pathogenesis of various diseases through the effective use of iPS cells, and
5) development of human disease models.

Decoding and Controlling Brain Information

Research Supervisor
Mitsuo Kawato
Director, ATR Fellow, ATR Brain Information Communication Research Laboratory Group

2008 – 2015

http://www.jst.go.jp/presto/bmi/index_E.html

This research area aims to create innovative technologies to exploit the brain information for motor control and decision-making. This subject covers areas of exploratory research and the development of technologies that is expected to greatly contribute to society and to connect basic neuroscience research and its newly emerging applied areas.

The main objective is to decode and control brain information from signals recorded from the brain so that extracted information is applied to areas such as brain machine interface (BMI), neurorehabilitation, neuromarketing, neuroeconomics, neurogenomics, and neuroethics.

From this perspective, this area includes various research approaches such as computational and experimental neurosciences, engineering, clinical medicine, biology, social sciences including economics, humanity sciences including psychology, as well as information science, which correspond with the expansion of brain science and its applied areas.

Innovative Nano-Electronics through Interdisciplinary Collaboration among Material, Device and System Layers

Research Supervisor
Takayasu Sakurai
Professor, Institute of Industrial Science, The University of Tokyo

Deputy Research Supervisor
Naoki Yokoyama
Fellow, FUJITSU LABORATORIES LTD.

2013 – 2018

http://www.jst.go.jp/kisoken/presto/en/research_area/ongoing/203nanoele.html

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.

Hyper-Nano-Space Design toward Innovative Functionality

Research Supervisor
Kazuyuki Kuroda
Professor, Faculty of Science and Engineering, Waseda University

2013 – 2018

http://www.jst.go.jp/kisoken/presto/en/research_area/ongoing/107space.html

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.

Molecular Technology and Creation of New Functions

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

2012 – 2017

http://www.jst.go.jp/presto/moltech/en/index.html

The purposes of this research area to cultivate and establish "Molecular Technology" that freely 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.

New Materials Science and Element Strategy

Research Supervisor
Hideo Hosono
Professor, Tokyo Institute of Technology

2010 – 2016

http://www.elest.jst.go.jp/en/index.html

It is known that the function of material is inseparably related with the elements of its own. However, existing elements are only about 100, and the number of elements which can be actually used for materials is becoming limited because of their scarcity and toxicity. Therefore, in order to create materials to support society and answer the social demand, scientists are required to re-create images of each element and to achieve the development of a new opportunity. Investigation of nano technology is selectively conducted worldwide, based on the common understanding that the development of science and technology in the nano area is indispensable for making rapid progress in materials science. From now on, the policy needs to be carried out that reflects each country's characteristics in addition to the basic understanding. "Element Strategy" is to achieve effective functions by using common elements as much as possible, the functions that have been realized by using rare elements until now. And, it is one of the scientific measures that Japan started for the first time in the world because of the scarcity of natural resources. This means "Element Strategy" is to establish a new materials science for a sustainable society from the academic standpoint.

This Research Area aims to establish a new materials science based on creating innovative functional materials using elements with a higher Clarke number by manipulating and utilizing nano structures, surfaces, interfaces, and defects and also based on theoretical modeling and advanced characterization, which will contribute to the green innovation to resolve resource, environment, and energy problems.

Innovative Use of Light and Materials/Life

Research Supervisor
Hiroshi Masuhara
Chair Professor, National Chiao Tung University

2008 – 2014

http://www.jst.go.jp/presto/raisha/english/index_e.html

The objective of this research area is to deepen studies and to create the seeds of the innovative technology by exploring light-related phenomena from the viewpoint of new light source in areas such as information/communication, nanotechnology/materials, life science, and environment/energy.

Specifically, this research area focuses on the studies for understanding the nature of light, making maximum use of light, synthesizing/characterizing/functionalizing molecular materials only with light, and processing/controlling chemical and biological production with light, which will be performed by applying various lasers with high power, ultrashort pulse width, and/or super long wavelength, synchrotron orbital radiation, extremely weak light, and single photon light source. Cellular function closely related with light, biological tissue structure revealed with light, and biological activity controlled only by light are important topics, while photonic measurement and dynamic imaging of substances and organism are included.

Nanosystems and Emergent Functions

Research Supervisor
Yoshihito Osada
Group Director, Advanced Science Institute, RIKEN

2008 – 2015

http://www.jst.go.jp/presto/emergence/english/index.html

This research area is to support original and challenging research proposals aimed at creating novel nanosystems with emergent functions. Here, the term "emergence" is defined as integrated and synchronized functions expressed at higher hierarchical level.

An important fact is that emergence often arises from newly organized macroscopic structures (or patterns and properties) autonomously formed as a result of a very large nonlinear ensemble of interactions at a lower hierarchical (elemental) level in an environment. From this perspective, this research area encourages researchers attempting to clarify the mechanisms and processes of emergence, or to design and create novel nanosystems with emergent functions.

One possible bottom-up approach is self-assembly and its applications that undergo spatial and temporal development. Top-down techniques that have made rapid progress in the fields of MEMS, robotics, and others are another option. However, an original approach fused with both bottom-up and top-down techniques could also be considered.

Collaborative Mathematics for Real World Issues

Research Supervisor
Hiroshi Kokubu
Professor, Graduate School of Science, Kyoto University

2014 – 2019

http://www.jst.go.jp/kisoken/presto/en/research_area/ongoing/109mathcollabo.html

To achieve breakthroughs in addressing of real world issues that have been difficult to solve through extensions of existing science and technology desperately requires solutions based on innovative concepts incorporating a broad array of ideas and approaches from modern mathematics. Producing those solutions requires that these issues be addressed from mathematical perspectives that widely range from pure mathematics, such as algebra, geometry, analysis, to applied, statistical, and discrete mathematics.

This research area aims to apply the full potential of mathematics to the resolution of real world issues and, within the process of addressing those problems, furthering the development of mathematics itself. In the pursuit of research, great emphasis will be placed on the researchers themselves experiencing the real world issues firsthand, so that they can develop their own awareness of the issues at hand and keep in mind the need for solution-oriented approaches as they advance basic research. It is expected that researchers in the mathematical fields will collaborate with theoretical and experimental researchers in the natural sciences, information sciences, engineering, and life sciences. Similarly it is expected that the researchers from various fields will be engaged in mathematical fields and work to solve issues. In the management of the research area, the research director will place great emphasis on researchers mutually influencing one another and working to solve problems from an interdisciplinary, integrative perspective. As a result, it is intended that a succession of young researchers will emerge to become future world-class leaders in the field of mathematical sciences.

Design of Information Infrastructure Technologies Harmonized with Societies

Research Supervisor
Hiroto Yasuura
Executive Vice President / Professor, Graduate School of Science, Kyushu University

2014 – 2019

http://www.jst.go.jp/kisoken/presto/en/research_area/ongoing/110socialinfo.html

Information technology (IT) is, nowadays, an infrastructure of various social systems as a nervous system of each community, and provides the most important means of value creation and problem solving in modern society. A new IT system is accepted by a society and causes social innovation, when the system is harmonized with culture and social moral, which evolve under natural and historical restriction of each society.

This research area provides researchers a field of discussions and practical experiences unifying basic technologies, social systems, service mechanisms, and business models to be harmonized the technologies with societies. Each researcher assumes an actual social problem, and proposes a scenario of solution acceptable by the society, as well as technologies such as artificial intelligence, computer science, sensor technology, network technology, simulation, robotics, human-machine interface and so on to solve the social problem. The research project is done by a fieldwork style for each real social problem, such as environmental monitoring or disaster preventions for global scale and social problems in local regions or communities.

Collaboration of IT people with researchers in natural science, engineering, life science and social science are strongly recommended. Reversely, researchers in various fields are also welcome to participating in this area. The goal of this research area is to foster leading IT researchers, who lead fusions of different areas for implementing social information infrastructure. We are planning to provide the researchers with opportunities of interchange with industrial leaders and policymakers.

Advanced Core Technologies for Big Data Integration

Research Supervisor
Masaru Kitsuregawa
Director General, National Institute of Informatics

Deputy Research Supervisor
Etsuya Shibayama
Professor, The University of Tokyo

2013 – 2018

http://www.jst.go.jp/kisoken/presto/en/research_area/ongoing/204bigdata.html

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.

Information Environment and Humans

Research Supervisor
Toru Ishida
Professor, Kyoto University

2009 – 2016

http://www.human.jst.go.jp/en/index.html

The goal of the research area is to conduct advanced research on intelligent functions where interaction with people is essential, to provide those functions in the form of sharable services embedded in the information environment, and to further form the composite functions based on provided services through networking with other services created both inside and outside of the research areas.

More specifically, the research area includes ubiquitous computing, ambient intelligence, intelligent robots, advanced research on intelligent functions to support communication and group activities; evaluation research on intelligent functions for users such as usability testing, ethnography, and statistical analysis; and further networking research on intelligent functions using services computing to provide research results to society.

Synthesis of Knowledge for Information Oriented Society

Research Supervisor
Hideyuki Nakashima
President, Future University-Hakodate

2008 – 2015

http://www.jst.go.jp/presto/info/english/index.html

This Research Area shall aim to develop fundamental technology for the generation of societally effective "knowledge" (useful information) from diverse and/or large-scale data.

Specific examples of research targets in this Area include: innovative technologies for the processing of large-scale data, technologies for analysis and modeling based on statistical and mathematical frameworks, technologies for extracting knowledge by structuralizing and analyzing diverse real-life data, and technologies for creating new knowledge from multiple resources (e.g. information acquisition through sensors and/or simulation results). In addition to these fundamental technologies, the Area includes research such as simulation and data visualization that support application of the obtained knowledge to real life; and that support the workings of the new information society.

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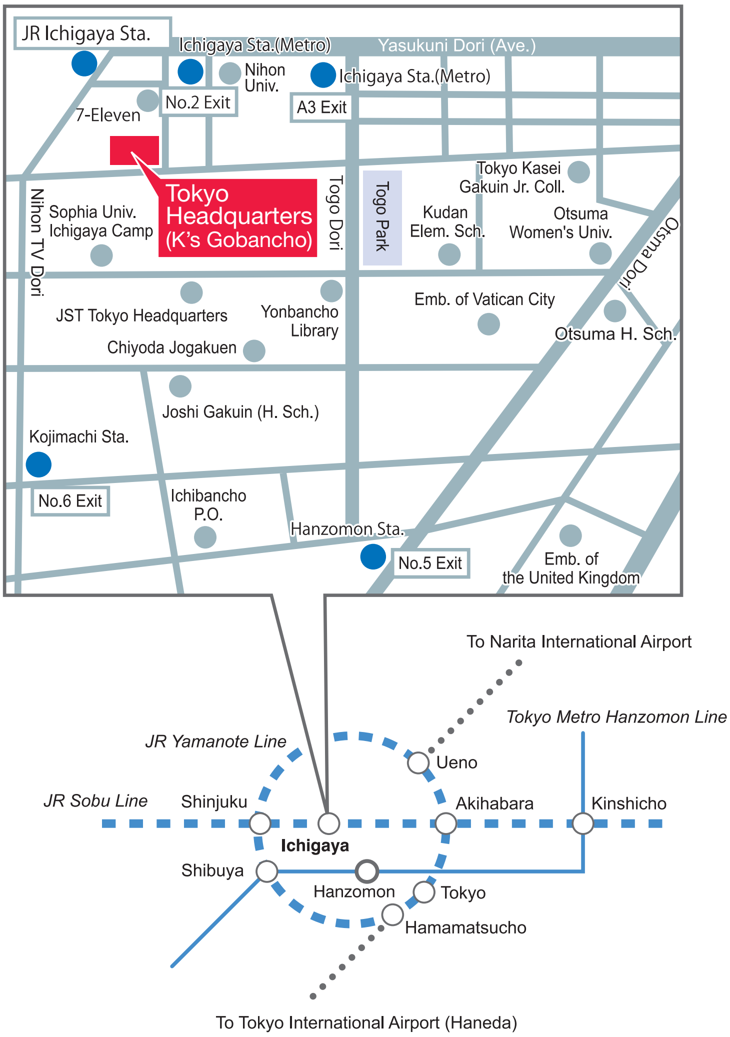

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