Attached Table 2　Research Outline of Research Areas Showed on Attached Table 1

When applying for Publicly Offered Research, the applicant should note the following points.

- Research period is 2 years (Application of research period other than this period is not subject to screening).

- The Principal Investigator cannot set up a team of project members together with a Co-Investigator. (However, Research Collaborator is allowed to participate in research project when necessary.)

- Please be aware that the maximum application amount listed is not the total amount for the research period (two years) but the amount equal to a single fiscal year.

- Please note that in principle, the allotted amount is in units of 100,000 yen.

- It is possible to apply and receive grants for up to 2 projects in Transformative Research Areas (A) (Publicly Offered Research) at the same time.
  For example, in case that grants have been received for 1 project continuation of which will be in FY2025 in Transformative Research Areas (A) (Publicly Offered Research), it is possible to apply for only 1 project in Transformative Research Areas (A) (Publicly Offered Research) for FY2025.

- Please refer to the website of each research area for the details of application contents.

Research Outline of Research Areas

Establishment of Child Poverty Research
https://www.poverty-research.jp

Number of Research Area	:	22A101	Term of Project :	FY2022-2026
Head Investigator	:	ABE Aya		
Research Institution	:	Tokyo Metropolitan University, Graduate School of Humanities		

1. Details of Research Area

This research area aims to upgrade poverty research in Japan into an academic discipline and in doing so, develop a research community who will lead an evidence-based policy making in the area of poverty alleviation. Even though the main focus of the research will be on child poverty, it is expected to expand to include poverty of other age category as well as poverty in general. However, since the Research Area's main goal is to build a community of researchers to interact with policy, the research will be focused on the poverty in Japan. The research area will construct a massive database by integrating data from social surveys on child poverty conducted by more than 300 municipalities around Japan. The database is expected to become one of the largest database on children with deprivation indicators which is becoming increasingly popular as a poverty index to supplement income-based poverty index. A group of researchers from multiple disciplines will jointly be involved in the design of the database, development of common poverty index, and its analysis. The analysis will consist of analysis of spatial and regional aspects of child poverty, analysis of small sample groups, analysis of the mechanisms connecting poverty and the child outcomes, and development of poverty alleviation systems and programs.

2. Call for Proposals and Expectations for Publicly Offered Research, etc.

The research area calls for innovative research related to child poverty, especially those pertaining to the below mentioned research areas. The research can be qualitative and quantitative empirical studies, policy research, meta-analysis, and international comparative studies. It is encouraged that research uses the child poverty database constructed by this research area but not limited to only those. Researchers from various academic fields are welcome. All projects should draw concrete policy implications at the end of the project.

【Research Group Area E01 Research on the effects of spatial and regional characteristics on child poverty】 The strength of the relationship between poverty and child outcome is influenced by regional characteristics (geographical, demographical, and social such as social capital, etc.). The quantitative and qualitative research investigating such spatial and regional aspects of poverty are invited.

【Research Group Area E03 Research on the poverty of small groups :】 Research of small groups such as single-father households, gender minorities, children with non-Japanese origin, children with health problems and disability, young cares is often difficult due to their limited sample size. The research proposal to utilize the child poverty database which should have enough sample size to investigate such groups are called for. Qualitative and policy research on poverty of these small groups is also welcome.

【Research Group Area E04 Research on the development of systems and programs to alleviate child poverty】 Research to develop systems and programs such as policies, business models, technologies and policy programs are invited. Research is not limited to actual programs to help the poor but also include research on effective advocacy, political and bureaucratic processes.

All research projects are expected to communicate closely with the Planned Research members and participate in Research Area events as much as possible, and to coordinate their research agenda with the main body of the Research Area.

3. Research Groups, Upper Limit of Annual Budget and Number of research projects scheduled to be selected

Research Group Number	Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
E01	Research on the effects of spatial and regional characteristics on child poverty	1	5
E03	Research on the poverty of small groups		5
E04	Research on the development of systems and programs to alleviate child poverty		5

Research Outline of Research Areas

Establishing data descriptive science and its cross-disciplinary applications
https://data-descriptive-science.org

Number of Research Area	:	22A201	Term of Project :	FY2022-2026
Head Investigator	:	HIRAOKA Yasuaki		
Research Institution	:	Kyoto University, Kyoto University Institute for Advanced Study		

1. Details of Research Area

The modern world is inundated with data. However, as seen in the black box problem in AI technology, it cannot be said that the true value contained in such data is being fully utilized. In order to make effective use of such big data, it is significant to describe the essential structure of the data in an appropriate mathematical language, and to use that descriptive language in the process of giving meaning and of understanding mechanisms behind the phenomena. In this Research Area, we will solve this problem by developing descriptors (mathematical languages that express the essential structure of data) that focus on the "shape" and "motion" of data, using state-of-the-art mathematical and data science methods. To this end, our Research Area is organized as a trinity of mathematics, data science, and application to create a new fusion area, "data descriptive science". The Planned Research consists of three groups. Research Group A01 will conduct mathematical and data science research for building theoretical foundations of data descriptive science. Research Group A02 will focus on research exploring new areas of data descriptive science. Research Group A03 will conduct research applying our methodologies to materials science and life science.

2. Call for Proposals and Expectations for Publicly Offered Research, etc.

We welcome research proposals for Publicly Offered Research from mathematics, data science, and applications. Proposals that are complementary to the Planned Research and actively promote fusion research are expected.

Research Group A01 calls for theoretical and methodological studies for the construction of data descriptive science. In mathematics research, we expect ambitious proposals for developing new data descriptors using, for example, probability theory, optimal transport, differential equations, variational methods, operator theory, etc. In data science research, the main themes are machine learning, representation learning, mathematical statistics, natural language processing, and time series analysis. We welcome research that bridges mathematics and data science. Research Group A01 mainly focuses on theoretical research, but also welcomes proposals that can conduct fusion research with applied themes in our Research Area.

Research Group A02 calls for a wide range of exploratory research on mathematics and applications that will open up new areas of data descriptive science. In mathematics research, the call is for research on developing new data descriptors using topology, representation theory, algebraic analysis, algebraic geometry, dynamical systems, etc., and research on data analysis using these methods. As for applied research, we expect data analysis research related to high-dimensional visualization, virtual reality, large-scale complex networks, and flow/transport phenomena on complex systems.

Research Group A03 calls for theoretical and experimental research on materials science and life science. In the Planning Research of materials science, we will visualize heterogeneity within materials in structural materials and energy materials using X-ray microscopy (XRM). As Publicly Offered Research, the open call includes applications of XRM to the other new areas (ex. earth science), proposals of new experimental approaches other than XRM for observation of heterogeneity, and proposals of analysis methods of multi-dimensional big data in terms of materials science. As life science themes, we envision proposals that challenge a variety of pattern formation processes at multiple scales, develop basic technologies for manipulating cell functions based on cell mechanics, and elucidate intracellular signaling networks and the mechanisms that determine cell diversity. The research equipment (XRM and confocal microscope) prepared in our Research Area can be used by Publicly Offered Research.

For Publicly Offered Research, it is not necessary to have conducted interdisciplinary research at the beginning of the research. For such proposals, opportunities for discussions shall be provided in consideration of the direction of data descriptive science, the expertise of the proposed subject, and the research subjects to be studied by Planned Research.

3. Research Group, Upper Limit of Annual Budget and Number of research projects scheduled to be selected

Research Group Number	Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A01	Basic Research	2	6
A02	Exploration Research	2	6
A03	Application Research	Theoretical research: 2 Experimental research: 3	3 3

Research Outline of Research Areas

Foundation of "Machine Learning Physics"
--- Revolutionary Transformation of Fundamental Physics by A New Field Integrating Machine Learning and Physics
http://mlphys.scphys.kyoto-u.ac.jp

Number of Research Area	:	22A202	Term of Project :	FY2022-2026
Head Investigator	:	HASHIMOTO Koji		
Research Institution	:	Kyoto University, Graduate School of Science		

1. Details of Research Area

In physics, which has traditionally progressed through both experiment and theory, the search for theoretical principles and mathematics and the development of experiments through technological development have revealed new aspects of space and matter. On the other hand, recent technological innovations such as machine learning have brought about social innovations. The objective of this research area, "Machine Learning Physics," is to integrate machine learning and data science methods including network science, etc., with theoretical methods in physics to discover new laws and explore new materials, which are fundamental issues in physics. This new research area integrates particle physics, condensed matter physics, gravity, computational physics, and machine learning from the viewpoints of mathematics, statistics, and topology.

Group A aims to solve fundamental problems in physics by integrating physics and machine learning, and Group B aims to develop methods to solve problems in physics by utilizing the affinity between machine learning and physics. Group B aims to develop methods to solve problems in physics through new fields that utilize the affinity between machine learning and physics. A01: Innovative acceleration of quantum computations in computational physics; A02: Improvement of the detection sensitivity of accelerator experiments and refinement of corresponding theories in particle physics; A03: Elucidation of quantum fluctuation and quantum entanglement in condensed matter physics and construction of condensed matter physics 2.0. A04: Emergence mechanism of space-time concepts in quantum and gravitational physics; B01: Mathematical study of the mechanism of deep learning using physics domain knowledge and classification of methods to deal with the problem; B02: Overcoming the problem of computational difficulty in learning by statistical mechanics/development of a framework that can be used throughout theory and practice. B03: Development of methods based on topological data analysis and physical processes of learning models.

2. Call for Proposals and Expectations for Publicly Offered Research, etc.

Since this research area integrates machine learning and physics, we aim to promote fusion through the participation of various researchers in machine learning, physics, and the surrounding fields of physics, and to create a new research field that transcends the boundaries of existing fields. For this reason, in addition to research proposals on themes deeply related to the research groups A01-A04 and B01-B03, we also expect related research proposals and stimulate fusion. In particular, for the latter, for example, desired are proposals that promote the fusion of diverse viewpoints, various fields of physics, and machine learning methods, proposals that contribute to the creation of a network of the entire area, and proposals that promote collaboration with surrounding academic fields.

The upper limit of the application budget is set at 1,000,000 yen/year for trial research, and 2,000,000 yen/year for developed numerical and theoretical research. We welcome applications from young researchers.

E01: Research proposals related to research groups A01, A02, and A04. Research proposals that are expected to interact with this research area in related research fields (including astronomy, quantum information, quantum computation, etc.).

E02: Research proposals related to research group A03. Research proposals that are expected to interact with this research area in related research fields (including physical chemistry, material informatics, brain science, biophysics, etc.).

E03: Research proposals developing/analyzing machine learning methods based on physical knowledge. Proposals related to research groups B01, B02, and B03. Research proposals that are expected to interact with this research area in related fields (including mathematical research on machine learning, etc.).

3. Research Group, Upper Limit of Annual Budget and Number of research projects scheduled to be selected

Research Group Number	Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
E01	Research using machine learning in quantum, particle, space-time, gravity, and related sciences	1 2	13 6
E02	Research using machine learning in condensed matter physics and related materials science	1 2	13 6
E03	Research proposals developing/analyzing machine learning methods based on physical knowledge	1 2	7 3

Research Outline of Research Areas

Systems biosynthetics based on accumulation, prediction, and creation of biological reactions
https://bio-4cast.skr.jp/en/

Number of Research Area	:	22A203	Term of Project :	FY2022-2026
Head Investigator	:	KUZUYAMA Tomohisa		
Research Institution	:	The University of Tokyo, Graduate School of Agricultural Life Sciences		

1. Details of Research Area

Natural products are very important research targets, not only for elucidating their behavior in living organisms but also for drug discovery applications. Although a large amount of genetic information related to the biosynthesis of natural products is now available, the structure, reactivity, and selectivity of biosynthetic enzymes have not been easily analyzed and clarified, and the biosynthetic pathways of many natural products have remained unknown. Therefore, this Research Area, "Forecasting Biosynthesis," will organize an organic and complementary collaborative research setting in close collaboration with the three Research Groups of (A01) accumulation, (A02) forecasting, and (A03) creation of biological reactions related to natural product biosynthesis. The objective of this Research Area is to open an innovative field of biosynthetic research that freely integrates two experimental disciplines, synthetic biology and synthetic organic chemistry, and closely links them with theoretical systems of informatics and computational science while incorporating artificial intelligence (AI) to create molecules at will. The AI to be developed in this Research Area is a system that can theoretically forecast the structure and biosynthetic pathways of new-to-nature compounds. To construct this forecasting system, it is essential to incorporate deductive methods such as theoretical calculations and quantum chemical calculations, which have been lacking thus far in this Research Area, in addition to existing inductive analytical methods. By constructing this forecasting system, we will initiate a fundamental change in the field of natural product chemistry from the conventional concept that has persisted for more than half a century—that natural products are to be "searched for"—to one in which natural products are "created."

2. Call for Proposals and Expectations for Publicly Offered Research, etc.

This Research Area should be composed of openly solicited researchers spanning a wide range of fields, including natural product chemistry, bioorganic chemistry, synthetic organic chemistry, synthetic biology, and structural biology in the experimental system and computational chemistry, theoretical chemistry, computational biophysics, and information science, in the theoretical system. To this end, the three Research Groups below will be established.

This Research Area aims to nurture a young generation of researchers who can use both experimental and theoretical approaches at will rather than simply collaborating with each other. Proposals from theoretical researchers who have not previously conducted research on living organisms but who are flexible and willing to collaborate with experimental researchers in this Research Area are welcome. Proposals from experimental researchers who are willing to actively develop joint research with theoretical researchers are also encouraged.

Research Group A01 (Accumulation of biological reactions) seeks to identify novel biocatalysts (enzymes) for the biosynthesis of the basic building blocks of natural products such as terpenes, polyketides, alkaloids, peptides, and their hybrids, derived from bacteria including actinomycetes, fungi, and plants, by using existing bioinformatics methods from the genome database and bioinformatics tools (initially in progress) to be developed under Research Group A02. This research will directly contribute to the construction of new scientific principles in biomolecular chemistry and related fields by discovering unknown functions and accumulating a large number of biological reactions through precise functional analysis and structural basis elucidation research.

Research Group A02 (Forecasting of biological reactions) calls for research aimed at (1) developing predictors that can predict biological reactions and (2) developing bioinformatics tools that can efficiently improve enzyme activity and extend substrate specificity by integrating structural prediction, machine learning, and quantum chemical calculations. The goal of developing these predictors is to obtain highly accurate tools that combine inductive methodology, which finds rules based on large amounts of empirical data, and deductive methodology, which derives useful information about biological reactions from the three-dimensional structure of enzymes based on theory. This includes, for example, a methodology that enables retro-biosynthetic analysis of natural products, a methodology that predicts the structure of natural products from genetic information alone, a methodology that compensates for the weak areas of the existing genome mining tool antiSMASH to increase prediction accuracy, and a methodology that uses bioinformatics tools to analyze multi-omics data to efficiently find new biocatalysts.

Research Group A03 (Creation of biological reactions) focuses on the expansion of biological reactions through approaches such as enzyme engineering by synthetic biology and evolutionary engineering; bioinformatics-based enzyme engineering using machine learning; molecular dynamics calculations, quantum chemical calculations, etc.; innovative enzyme control using decoy molecules; and chemical-enzyme hybrid synthesis. We call for research that develops new methods of molecule creation by extending biological reactions through approaches such as molecular design strategies that revolutionize biosynthesis to develop environmentally benign material production processes, create a large number of novel bioactive compounds, and extend the space of compounds that can be produced by biocatalysts. This group will play an important part in increasing the number of compounds that are output by this Research Area and improving the diversity of molecular structures.

3. Research Group, Upper Limit of Annual Budget and Number of research projects scheduled to be selected

Research Group Number	Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A01	Accumulation of biological reactions	4.5	14 projects together with Group A03
A02	Forecasting of biological reactions	4.5	10
A03	Creation of biological reactions	4.5	14 projects together with Group A01

Research Outline of Research Areas

Revolution of chiral materials science using helical light fields
http://light-chiral-materials-science.jp/en_front/

Number of Research Area	:	22A204	Term of Project :	FY2022-2026
Head Investigator	:	OMATSU Takashige		
Research Institution	:	Chiba University, Graduate School of Engineering		

1. Details of Research Area

An object is chiral if it cannot be superimposed onto its mirror image. In general, chiral objects have the same chemical and physical properties as their mirror images but different optical properties (e.g. circular dichroism), and they play universally important roles in materials science. Also, chiral objects possess typically helical structures, such as spirals and vortices on a nano/macro-scale.
Helical light fields encompass optical vortices with helical wavefronts, vector vortex beams with polarization singularity, and plasmonic enhanced circularly polarized light fields, and they have been widely investigated across a broad range of applications. These exotic optical fields possess an effective wavelength much shorter than that of conventional plane waves in free space.
This research area aims to freely manipulate a myriad of nano/micro-scale materials using helical light fields to establish exotic micro-scale and macro-scale helical structures with multifunctional properties.
Using these structured materials, we further aim to pioneer innovative materials sciences and advanced materials technologies, such as chemistry with helical light fields, engineering with light induced helices, and physics in vortices.

2. Call for Proposals and Expectations for Publicly Offered Research, etc.

This research area consists of 10 planned research projects classified into three sub-projects as follows:
[A] fundamental studies of physical and chemical phenomena via interaction between helical light fields and matters
[B] direct observation of spatio-temporal evolution of the interaction between helical light fields and matters
[C] fabrication and assembly of multi-scale functional helical structures and discovery of exotic interactions between helical-light fields and matters.

This research project aims for the following three goals.
(1) Chiral crystallization at ultimate chiral bias, and ultrahigh sensitive detection of chirality at an ultrahigh spatial resolution. We herein refer 'chemistry with helical light fields'.
(2) Biomimetics with light-induced helices, and tissue engineering with light-induced helices. We herein refer 'engineering with helical-light induced helices'.
(3) Creation, annihilation and manipulation of nano/micro-scale vortices, such as quantum vortices and skyrmions, with helical-light fields. We herein refer 'physics in vortices'.

We expect that the publicly offered research proposals will reinforce and promote the aforementioned subprojects [A]-[C], and they will contribute significantly to achievement of the aforementioned goals (1)-(3).
Also, we expect that the publicly offered research projects will enable the improvement of the universal and academic achievements of this project and the establishment of further interdisciplinary research areas based on interaction between helical light fields and materials beyond the planned research projects.

3. Research Group, Upper Limit of Annual Budget and Number of research projects scheduled to be selected

Research Group Number	Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A04	Fundamentals of helical-light induced chiral materials science	Experimental research : 3 Theoretical research : 2	18 3
B04	Direct observations of helical-light induced chiral materials science		
C05	Demonstrations of helical-light induced chiral materials science and technology		
D01	Interdisciplinary research projects based on interaction between helical light fields and materials beyond three sub-projects		

Research Outline of Research Areas

Supra-ceramics: Molecule-driven frontier of inorganic materials
http://supraceramics.jp

Number of Research Area	:	22A205	Term of Project :	FY2022-2026
Head Investigator	:	MAEDA Kazuhiko		
Research Institution	:	Tokyo Institute of Technology, School of Science		

1. Details of Research Area

In this research area, we define "supra-ceramics" as a group of materials in which molecular units (molecular ions, complexes, clusters, etc.) are incorporated into inorganic materials, and create new materials with innovative properties and functions through cross-disciplinary research that brings together researchers from different fields. The objective is to revolutionize the academic system of materials science, focusing on inorganic materials. In this research area, the target supra-ceramics are classified into the following two types according to the way in which molecular units are incorporated, and the creation of new materials of both types will be pursued.

Endospheric supra-ceramics: New materials that contain molecular ionic species within the lattice of inorganic crystals. Based on the strong electronic interactions within the narrow space of the crystal, new properties and functions that cannot be created by conventional molecular ion-containing materials (MOFs, etc.) are expected to be created.

Exospheric supra-ceramics: New materials that have outstanding properties and functions by placing functional molecules at specific locations on the surface of inorganic solids. Unlike conventional organic-inorganic hybrids, perturbations from crystal surfaces or interfaces are maximally utilized to create new structures and electronic states that inorganic solids or molecules alone do not possess, leading to modulation of physical properties and functions.

2. Call for Proposals and Expectations for Publicly Offered Research, etc.

In this research area, we will construct a materials design science of supra-ceramics based on close collaboration among "synthesis," "analysis and theory," and "physical properties and functions". Research Teams A01 and A02 are defined as Group A, and Research Team A03, which consists of publicly offered researches, is established in Group A. Similarly, Groups B and C are defined, and Research Teams B03 and C03 are established, respectively. We wish to expand the entire research area by including important research topics that are not included in the current research plan as publicly offered research, thereby providing a driving force for research in the area. We expect applications from various materials-related fields, such as solid-state chemistry, coordination chemistry, crystallography, supramolecular chemistry, catalysis, and condensed matter physics. We consider the possibilities of the following subjects in each research category, for example, but also welcome original one that is not covered by these categories.

Group A: Research on the synthesis of materials using electric fields, high pressure, etc., synthesis of materials under special atmospheres, development of processes to precisely control the chemical composition and arrangement (regular or irregular arrangement) of molecular ions and organic ligands, and establishment of guidelines for controlling dimension and morphology including nano- and macrostructure.

Group B: Structural dynamics of supra-ceramics, development of electronic structure measurement devices and analytical methods for light elements, analytical methods using first-principles calculations, etc., of data from analytical electron microscopes and various spectroscopic methods, chemical bonding of supra-ceramics, understanding and prediction of physical properties Theoretical calculation techniques for understanding and predicting chemical bonding and physical properties of supra-ceramics, prediction of materials and composition using materials informatics, etc.

Group C: Experimental/theoretical studies on the creation of properties and functions of supra-ceramics. Bulk properties of materials, interfacial properties including thin films, electronic devices, catalysts, biomaterials, etc.

3. Research Group, Upper Limit of Annual Budget and Number of research projects scheduled to be selected

Research Group Number	Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A03	Development of new synthesis method and dimensional/ morphological control of supra-ceramics	2.3	11
B03	Design and advanced structural analysis of supra-ceramics	2.3	6
C03	Development of new properties and functions of supra-ceramics	2.3	13

Research Outline of Research Areas

Biogeochemistry of CO worlds
http://co-world.jp

Number of Research Area	: 22A206	Term of Project :	FY2022-2026
Head Investigator	: UENO Yuichiro		
Research Institution	: Tokyo Institute of Technology, Graduate School of Science		

1. Details of Research Area

This research area aims to elucidate the planetary environment necessary for emergence of life, through interdisciplinary study of "CO worlds" in which organic molecules are generated from carbon monoxide. Recent astronomical observations and planetary exploration missions have discovered habitable environments beyond the Earth; however, we still do not understand what kind of planetary environment is necessary for the emergence of life. In this research area, we investigate the diversity of possible planetary environments, systematically focusing on major carbon species (CO_2/CO/CH_4) according to the redox state. An environment rich in CO is particularly suitable for synthesizing various organic molecules. It is also interesting that the earliest carbon fixation by Earth's life (the acetyl-CoA pathway) can use CO as a carbon source. Furthermore, recent geochemical and theoretical studies have provided evidence for the presence of CO in the atmospheres of the early Earth and Mars.

Based on these considerations, this research area will promote study of CO worlds by integrating four research fields. Theory Group (A01) and Geochemistry Group (A02) will investigate how much CO is present in the atmosphere of the early Earth, Mars and other planets including exo-planets, and characterize which organic molecules are produced in each atmosphere, The two groups conduct model calculations of planetary atmosphere and material cycling together with geochemical observations and experiments of atmospheric molecules including stable isotope species (isotopologues). In parallel, the Biology Group (A03) and Chemistry Group (A04) will clarify what kind of ecosystem, metabolism and chemical reaction system are established under such a planetary environment. The presence of organic molecules is not enough to create life. Rather, a chemical system itself must arise in the environment for providing building blocks of life. By focusing on CO, this research area plans to demonstrate that a chemical system capable of evolving into life (geometabolism) can be established in the actual planetary environment. Through this interdisciplinary research, we aim to revolutionize the astrobiology research field, and provide more concrete methods for discriminating traces of life (biosignatures) in future astronomical observations and planetary explorations.

2. Call for Proposals and Expectations for Publicly Offered Research, etc.

One of our goals is to extend "biogeochemistry" of the Earth into other planetary systems. Further, we aim to facilitate the search for life in the universe, as well as microbiology and chemistry research fields initiated from the study of CO worlds. Therefore, we are seeking proposals to award as Publicly Offered Research in various fields, not only planetary science and geochemistry, but also microbiology, mathematical science, synthetic chemistry, and the fusion of these areas. The followings are examples of reserch topics related to each Research Group:

- A01 and A02: Redox evolution of planetary atmospheres focusing on carbon species; Observation or theory of CO and biosignatures in exoplanet atmospheres; Modeling of biogeochemical cycling via CO; The CO_2 stability problem in planetary atmospheres; Development of stable isotope methodology and its applications as biomarker; Paleoenvironmental reconstruction using stable isotope anomalies; Chemical and spectroscopic observations of planetary atmospheres, etc.
- A03 and A04: Autocatalytic synthesis and/or asymmetric amplification of building block molecules such as amino acids; Interaction between metal, CO and organic molecules; Theory of autocatalytic systems established in planetary environment; Carbon fixation by electro-, photo-, and thermo-catalytic chemistry in CO environments; Biochemistry of CO metabolizm such as acetogenesis; Evolutionary analysis of carbon fixation and energy metabolism; Microbial ecology in extreme environment; Reconstruction of ancestral enzymes and their functional analysis, etc.

We also welcome innovative and challenging proposals that do not fit within these frameworks. The guideline for making these Publicly Offered Research awards is 3 million yen or less for 12 projects for theoretical and small-scale experimental research. We intend to select 3 larger projects supported at 8 million yen or less for experimental research in topics of particularly high priority.

3. Research Group, Upper Limit of Annual Budget and Number of research projects scheduled to be selected

Research Group Number	Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A01	Theoretical modeling of CO world	3.0	12
A02	Decoding CO world in early Earth and Mars		
A03	Biology of CO world	8.0	3
A04	Chemistry of CO world		
B01	Interdisciplinary research connecting from A01 to A04		

Research Outline of Research Areas

Deciphering and Manipulating Brain Dynamics for Emergence of Behaviour Change in Multidimensional Biology

http://braidyn-bc.jp

Number of Research Area : 22A301 Term of Project : FY2022-2026
Head Investigator : MATSUZAKI Masanori
Research Institution : Graduate School of Medicine, The University of Tokyo

1. Details of Research Area

In the process of human behavior change, multidimensional behavior changes, i.e., not only changes of the goal-directed behavior, but also changes such as facial movements that may be related to internal states such as motivation, conflict, and joy of success, often appear. This should be common not only to humans but also to many animal species, but it is difficult to measure detailed behavioral changes in small animals such as mice, and has been overlooked in many studies. However, with the rapid progress of AI technology in the past few years, it has become possible to extract with high precision the movements of a mouse's entire body, including its eyes, whiskers, tongue, jaw, and other facial features, from video data alone. In this Research area, we aim to "quantitatively" elucidate the relationship between multidimensional behavioral change and brain dynamics (brain information dynamics, which is neural activity that encodes information at a given moment, the dynamics of synaptic connections and molecular expression that define the neural activity, metacognition, and meta-learning). We will also investigate the principles by which the dynamics of related circuits operate to generate behavioral change, how this relationship differs between individuals and between healthy and diseased individuals, and whether direct manipulation of the dynamics of related circuits or behavioral interventions can promote the desired behavioral change.

2. Call for Proposals and Expectations for Publicly Offered Research, etc.

Publicly Offered Research is invited for studies that fall under Research Groups A01 and A02. Research on the development of techniques and tools to measure and manipulate behavior change and brain dynamics with multidimensional high precision is also welcome. Target animals are not limited to mammals. The administrative group promotes the openness of measurement, standardization, and analysis methods for multidimensional data, and we encourage research that actively uses these methods to analyze multidimensional data obtained. The administrative group now acquires behavioral change data and brain dynamics data from mice and demonstration data are available at https://braidyn-bc-database.netlify.app/. Research that focuses on the analysis of data acquired by the administrative group without an animal experiment plan is also highly welcome. We are seeking participation from a wide variety of researchers, and we especially encourage young researchers and female researchers to actively apply.

In Research Group A01, "Wide Brain Dynamics of Behavior Change", we welcome proposals that measure or manipulate brain dynamics of behavior change, including social behavior change, metacognition that unconsciously defines behavior change, developmental and aging-related behavior change, and disease models, as well as research on computational models, simulations, and robotics that relate these studies and behavioral interventions. We welcome research that attempts to clarify the relationship between behavioral change and brain dynamics through behavioral interventions. We also welcome proposals on the development of methods to standardize behavioral changes and brain dynamics among individuals and to extract interspecies commonalities, as well as research mainly on analysis using mouse behavioral and brain dynamic data obtained by the administrative group.

In Research Group A02, "Interactions between Wide and Local Brain Dynamics", we welcome proposals that relate not only local brain activity but also dynamics at the single cell level and single synapse level to multidimensional behavior change based on rigorous cellular construction, and model brain circuits. We welcome proposals that perform dimensional reduction of multidimensional data, and extract behavioral changes common to the task. We are also looking for research that takes a broad view of brain dynamics, including neuronal activity by action potentials, changes at the gene and protein levels, glial cell dynamics, autonomic and peripheral nerve dynamics, and brain dynamics related to immunity and inflammation, brain-gut interaction, etc., and acquires and analyzes such multidimensional data. We welcome highly motivated research that seeks to elucidate the mechanisms of behavioral change through strong collaboration by sharing and standardizing multidimensional data within this Research area.

3. Research Group, Upper Limit of Annual Budget and Number of research projects scheduled to be selected

Research Group Number	Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A01	Wide Brain Dynamics of Behavior Change	3	10
A02	Interactions between Wide and Local Brain Dynamics	3	10

Research Outline of Research Areas

Mechanical self-transformation of living systems
http://multicellular-mechanics.org

Number of Research Area	:	22A302	Term of Project :	FY2022-2026
Head Investigator	:	MOTEGI Fumio		
Research Institution	:	Institute for Genetic Medicine, Hokkaido University		

1. Details of Research Area

Elucidating the design principles of multicellular organisms is a fundamental challenge in the life sciences. The global order of an organism generally emerges from local interactions between molecules and cells. Collectively, these interactions - referred to as self-organisation - give rise to the emergent properties of cell fate and function, ultimately leading to the morphogenesis of tissues and organs. Mechanical forces that induce changes in cell size, shape and position are integral to the morphogenetic processes, and indeed play instructive role in modulating cell fate and function, suggesting the existence of a complex feedback between forces and cell physiology.

This research area aims to develop new paradigms of morphogenesis by quantitatively and holistically assessing how mechanical forces control emergent properties of self-organising feedback in morphogenesis. By harnessing the power of cutting-edge technologies to measure and manipulate the magnitude and distribution of forces within cells and extracellular spaces, we will understand how these forces trigger self-organising feedback that leads to progressive self-tuning transformation of multicellular systems over longer timescales.

Our planned research consists of three research groups: A01 and A02 will elucidate mechanical self-organisation in a wide range of multicellular systems, while B01 will develop new techniques for measurement and analysis of mechanics, as well as theoretical framework for modelling and numerical simulation of self-organisation. Through organic collaborations within this multidisciplinary groups, we will uncover new insights into mechanical self-organisation and achieve a paradigm shift in the understanding of biological design principles.

2. Call for Proposals and Expectations for Publicly Offered Research, etc.

We invite publicly offered research groups (A03 and B02) that quantitatively measure and analyze mechanical forces by inventing new techniques of cell and tissue manipulation. We expect research proposals that will investigate the physiological functions of mechanical forces by manipulating forces within cells and tissues while applying theoretical analysis. We also seek research proposals that develop new model systems for studying mechanical self-assembly events. These projects are expected not only to complement and strengthen the planned research, but also to challenge the establishment of innovative techniques to further accelerate the overall research goals.

The A03 group aims at investigating the self-organization of unique biological systems including, but not limited to "*ex vivo* analysis of tissue morphogenesis", "formation of organoids derived from differentiated stem cells", and "reconstituted systems by restructuring cellular interactions." These projects will improve our understanding of extracellular mechanics and reveal how multicellular systems sense and respond to external forces. In addition, we encourage challenging proposals that, for example, the use of "unconventional animal and plant models" and investigating "non-biological forces" (e.g., gravity, atmospheric or water pressure, and geomagnetism). A proposal addressing disease and ageing would also be considered if it fits within the overall objectives.

The B02 group aims to develop innovative techniques for the quantitative measurement, manipulation, and evaluation of various types of forces in multicellular systems. In particularly, proposals on the development of force biosensors and force-measuring technologies that can be applied to cell surfaces, nuclear membranes, and the lumenal surfaces of embryos and tubular organs are highly encouraged. We also welcome the development of new technologies for manipulating in vivo forces such as optogenetics, material engineering, and MEMS technology. B02 also welcomes "dry" proposals that focus on the theoretical investigation and mathematical modelling of mechanical self-organization.

3. Research Group, Upper Limit of Annual Budget and Number of research projects scheduled to be selected

Research Group Number	Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A03	Research on mechanically self-organizing multi-cellular systems	5.00 (wet) 3.00 (dry)	12 5
B02	Development of techniques for measurement, manipulation, and theoretical analysis of mechanical self-organization		

Research Outline of Research Areas

Genomic dynamics underlying the plastic hermaphroditism in plants: the basis of exploratory reproductive adaptations.
http://www.ige.tohoku.ac.jp/prg/flower/

Number of Research Area	:	22A303	Term of Project :	FY2022-2026
Head Investigator	:	AKAGI Takashi		
Research Institution	:	Okayama University		

1. Details of Research Area

Plants have evolved hermaphrodite flowers, in which male and female functions can coexist. Hermaphrodite flowers have allowed flexible bidirectional transitions between two contrasting reproductive systems, selfing and out-crossing, to explore a wide range of environments. In other words, in plants, multiple lineages have constantly but independently established various out-crossing systems from the ancestral hermaphroditism, while they could have disrupted them to reverse into selfing, as an adaptation. These recurrent "scrap and rebuild" would be a nature of evolution in plant reproductive systems.

The rapid scraping and rebuilding cycles in the plant reproductive systems have left strong traces on the evolution of their drivers. In turn, various evolutionary indexes in genomic information and protein interactions/conformations of these factors would be nice materials to visualize their history of exploration. Thus, plant reproductive biology is a challenging field to integrate conventional biology with various advanced information sciences, including recent AI technologies based on large-scale genomic and evolutionary information. In actuality, with a collaborative application of advanced information technologies and whole-genome sequencing across plant species, this research area preliminarily found that the establishment of hermaphrodite flowers and their plastic transitions into out-crossing systems had a fundamental impact on the history of plant reproduction.

In this research area, we will overlook the various transitions of plant reproductive strategies and find their potential links, with advanced information science platforms, integrating molecular dynamics simulation, genome evolution, structural biology, and chemical biology, etc. Our final aim is to elucidate "genome dynamics triggering exploratory reproductive adaptations, based on the plastic hermaphroditism", which goes beyond the conventional research frameworks.

2. Call for Proposals and Expectations for Publicly Offered Research, etc.

We expect publicly offered research that can complement the topics not covered by the existing research groups, and can develop new technologies by collaborative integration with our technologies in the Research Support Centre for Interdisciplinary Science consisting of seven research units; information technology (AI) unit, genome and mathematical modeling unit, evolutionary biology unit, structural imaging unit, chemical and molecular dynamics unit, single-cell omics unit, and high-throughput genome-editing unit. We target research with various plant species, in plant physiology, biochemistry, molecular genetics, and genetic breeding. We also welcome proposals from emerging fields that integrate structural biology, molecular cell biology, evolutionary ecology, genomics and epigenomics, information science, structural systems science, and molecular dynamics simulation, etc.

This research area will adopt a total of approximately 15 publicly offered research proposals aiming for a synergistic effect through collaboration with the existing research groups. A two-stage research fund allocation will be planned, taking into account the research contents and environments. Approximately five research projects, with high relevance and performance in relation to our research area, and with the potential for drastic development, will be selected to allocate a budget of JPY 7,000,000/year. Approximately 10 projects will be selected for exploratory topics, including by young researchers, to allocate a budget of JPY 4,500,000/year.

3. Research Group, Upper Limit of Annual Budget and Number of research projects scheduled to be selected

Research Group Number	Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A01	Genomic dynamics underlying the plastic hermaphroditism in plants: the basis of exploratory reproductive adaptations	7 4.5	5 10

Research Outline of Research Areas

Reevaluation of self-recognition by immune system to decipher its physiological advantages and pathological risk
https://self-ref-imm-percept.biken.osaka-u.ac.jp

Number of Research Area	:	22A304	Term of Project :	FY2022-2026
Head Investigator	:	YAMASAKI Sho		
Research Institution	:	Osaka University, Research Institute for Microbial Diseases		

1. Details of Research Area

Immunology has become an extremely familiar field of science to the general public. We all now appreciate that antibody medicine has opened up new avenues for the treatment of various diseases and that vaccines have become common throughout the world in a short period of time. Thus, immunology is a scientific field that is directly related to human diseases and the results of basic research have directly led to contributions to society. However, there remain many immune diseases and phenomena that have not been elucidated. To address this, we need a systematic approach based on new technologies and perspectives that go beyond conventional views.

The immune network was considered to be a system that monitors exclusively "outward", such as pathogens. However, recent studies have revealed that many immune sensors are also looking "inward" to detect perturbations derived from external/internal stresses by sensing alteration of self-molecules, such as proteins, nucleic acids, lipids, sugar chains, metabolites, etc. Thus, various physiological processes which utilize these organic substances can be directly or indirectly linked to the immune system. Elucidating the mechanisms of self-recognition by immune sensors will advance our understanding of physiological responses and diseases that are not currently linked to the immune system.

Hence, we propose a new concept "self-referential immune perception" that reevaluates self-recognition by immune system to decipher its physiological advantages and pathological risk. Our goal is to advance scientific understanding of currently unsolved immune-related and broader physiological responses. We aim to (1) identify self-components recognized by immune sensors using cutting-edge technologies, (2) clarify the molecular basis of the self-protective response inherent in the immune system by focusing on its physiological and pathological sides, and (3) develop a methodology that enables the prediction of health status by utilizing the self-interactome database established in this research area.

2. Call for Proposals and Expectations for Publicly Offered Research, etc.

The open call for research proposals will be based on the concept mentioned above that complement or greatly develop our research activities. A total of approximately 25 research proposals of up to 3 million yen per single year are invited under A01 and A02. We welcome research proposals focusing on the beneficial responses caused by self-recognition, and do not limit the field related to immune responses and diseases. We also expect to have challenging projects that aim to elucidate various physiological responses and disease mechanisms in a broad range of fields. The definition of "immune sensor" in our research area is "a receptor or related molecule that is known to or expected to recognize "foreign" substances". There is no restriction for target organisms unless it does not fit our research concept. We are particularly interested in challenging proposals from young researchers, female researchers, and researchers currently studying abroad who are eligible to apply.

A01: Molecular basis of self-recognition and function

We aim for the strategic identification of self-components recognized by various immune sensors. We expect research proposals that go beyond identification of such self-components and aim to elucidate the beneficial biological responses. We also expect basic research aiming at establishing new technologies for molecular interaction, molecular identification, and mathematical/informatics analysis. Proposals for innovative methodologies that integrate the data accumulating in this field are also welcome. Research projects that focus solely on pathogen recognition will not be considered.

A02: Advantageous or pathophysiological responses triggered by self-recognition

We expect research proposals that address the physiological advantages of self-recognition by immune sensors straightforwardly, or through analysis of the detrimental effects caused by its dysregulation. This research may include clinical approaches using human samples. One of our final goals is to create a system to monitor and predict our health status using our interactome database. Thus, research proposals aiming to develop new nonlinear data analysis, machine learning, and multivariate analysis are welcome.

3. Research Group, Upper Limit of Annual Budget and Number of research projects scheduled to be selected

Research Group Number	Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A01	Molecular basis of self-recognition and function	3	25
A02	Physiological or pathogenic responses triggered by self-recognition		

Research Outline of Research Areas

Photonic Computing Highlighting Ultimate Nature of Light
https://www.photoniccomputing.jp/

Number of Research Area	:	22A401	Term of Project :	FY2022-2026
Head Investigator	:	KAWANISHI Tetsuya		
Research Institution	:	Faculty of Science and Engineering, Waseda University		

1. Details of Research Area

To meet the ever-growing demands of information communication and processing and to support the sustainable development of an advanced information society, it is expected that new computing principles and technologies utilizing physical processes will be created. This research area which aims to create photonic computing by integrating optical science and technology with information science and technology, focusing on leveraging the "extreme performance of light." will explore various characteristics of light, such as high-speed propagation, low loss, wide bandwidth, multiplexing, and real-world interaction capabilities. This research area is organized into three research pillars, each with specific goals and content:

Research Pillar A (Planned Research A01, A02): "System architecture to benefit from the ultimate nature of light", which focuses on overcoming the architectural limits that hinder the use of light in computing and researching system architectures that fully utilize the inherent performance of light. Specific topics include photonic approximation computing that maximizes the high speed and multiplexing of light and task decomposition for optimal integration of photonic and electronic systems.

Research Pillar B (Planned Research B01, B02, B03): "Computing mechanism to exploit the ultimate nature of light", which aims to develop computing mechanisms that utilize the physical limits of light, such as its spatiotemporal multiplexing and multi-valued representation capabilities. Specific topics include photonic reservoir computing, the application of extreme light modulation in computing, and the creation of advanced optical functions such as optical decision-making.

Research Pillar C (Planned Research C01, C02): "Device fundamentals to benefit from the ultimate nature of light", which focuses on innovating device platforms to draw out the unexplored potential of light. Specific topics include integrated photonic devices for computing that utilize the multiplexing of light and the fusion of ultra-high-frequency electronics and photonics to overcome bottlenecks between optical and electronic systems.

2. Call for Proposals and Expectations for Publicly Offered Research, etc.

We are soliciting original and pioneering research proposals related to photonic computing that leverages the extreme performance of light, targeting all three research pillars (A, B, and C). The fusion of photonics and computing is a rapidly advancing field, with efforts to realize optical matrix-vector operations through the progress of silicon photonics integration technology. Applications requiring functionalities and performances significantly different from traditional systems, such as digital twins and generative AI, are rapidly expanding, marking a crucial transformative period for creating new academic foundations supporting next-generation information processing infrastructures. The role of the solicited research is to expand and deepen research that leads to academic transformation, ranging from academic foundations to practical application deployment. However, the duration and funding for the solicited research are limited. Therefore, research proposals must be highly original and pioneering. Proposals should focus on one of the research pillars: A (computer science, applied systems, mathematical sciences), B (information physics, information optics, quantum science, nonlinear science), or C (optical devices, electronic devices, materials science), emphasizing the unique perspectives of "architectural limits (Pillar A)", "extreme performance (Pillar B)", or "unexplored potential (Pillar C)". Moreover, this research area requires a certain consideration of future applications even for fundamental research. This does not mean that research development must include content premised on social implementation but rather that the proposal should consider the relevance to applications and connections with other research. The research area encompasses a wide range of disciplines, including optical science, information science, computer science, electrical and electronic engineering, communication engineering, mathematical sciences, and materials engineering. Additionally, regarding application and use case studies, the research should have broad applicability beyond traditional computing and information communication technologies. An important role of the solicited research is to strengthen and develop researcher networks, including young researchers, by collaborating with diverse academic fields involved in this research area.

3. Research Group, Upper Limit of Annual Budget and Number of research projects scheduled to be selected

Research Group Number	Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A03	System architecture to benefit from the ultimate nature of light	2.5	10
B04	Computing mechanism to exploit the ultimate nature of light	6	5
C03	Device fundamentals to benefit from the ultimate nature of light		

Research Outline of Research Areas

Macro coastal oceanography: integrated simulation for the material dynamics from the land through the open ocean
https://macrocoast.jp/

Number of Research Area	:	22A402	Term of Project :	FY2022-2026
Head Investigator	:	HASUMI Hiroyasu		
Research Institution	:	The University of Tokyo, Atmosphere and Ocean Research Institute		

1. Details of Research Area

The coastal zone environment is changing due to human activities. Global scale changes in the ocean associated with global warming affect the coastal zone, while the supply of various anthropogenic substances is increasing from the land. Rivers, which transport material from the land to the coastal zone, are also affected by global warming. For example, the intensity and frequency of flooding discharge are increasing in Japan. There is an increasing need for prediction and impact assessment for the coastal zone. Still, the current simulations cannot meet such a need because the influences from the land and the open ocean are not sufficiently considered. This Research Area aims to transform the coastal oceanography into a "macro"-scale framework to properly include the influences from the land and the open ocean. Thereby, we intend to realize such a simulation that can properly predict the ongoing changes in the coastal zone and assess the impact of such changes.

This Research Area focuses specifically on the dynamics of nutrients in the coastal zone around Japan. Nutrients are supplied to the coastal zone from the land and the deep open ocean, and both are rapidly changing under human influence. We aim to understand and predict it by properly considering its interaction with the land and the open ocean. One of our goals (the "milestone" of this Research Area) is to comprehensively answer the classical question: Which of the land and the open ocean is dominant in the supply of nutrients that sustains the biological production in the coastal zone?

2. Call for Proposals and Expectations for Publicly Offered Research, etc.

Planned Research is grouped into A (focused on the coastal zone), B (focused on the open ocean), and C (focused on the land). Group A comprises A01 which is focused on physical processes, A02 which is focused on material dynamics, A03 which is focused on ecosystem processes, and A04 which develops an integrated simulation system from the land through the open ocean with an emphasis on the coastal zone. Group B includes B01 which is targeted at the subpolar region, B02 which is targeted at the subtropical region, and B03 which conducts simulations for the entire North Pacific. C01 deals with the terrestrial nutrient dynamics with a focus on its influence on the ocean. We expect Publicly Offered Research to complement and extend Planned Research and to contribute to the above-mentioned integrated simulation system and milestone. We welcome numerical modeling studies aiming at obtaining synthetic views based on the results by Planned Research. More specific themes are as follows:

A01, A02: Marine ecosystem modeling and fishery species habitat mapping utilizing the understanding of the nutrient transport obtained by Planned Research. **A03**: Modeling studies on the iron dynamics in coastal waters collaborating with the observations by Planned Research. **A04**: Studies assessing or validating the numerical modeling system developed by Planned Research by applying it to actual events. **B01**: Modeling studies on the dynamics of land-origin nutrients and their influence on biological productivity. Studies on the impact of land-origin nutrients on the marine ecosystem. **B02**: Modeling studies on the transport processes of nutrients in the Kuroshio region and around. Studies on the nutrient budget in the western North Pacific in long timescales. **B03**: Data assimilation studies that extend the understanding obtained by Planned Research to other oceanic regions. **C01**: Modeling studies assessing the impact of land water on the coastal marine ecosystems. Studies on the influence of land-origin freshwater and nutrients on the large-scale (over a broad area of coastal regions or from the coastal waters to the open ocean) physical ocean circulation, marine material cycles, and ecosystems.

3. Research Group, Upper Limit of Annual Budget and Number of research projects scheduled to be selected

Research Group Number	Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A01	Flow variability and material dispersion in the coastal zone	5	6
A02	Dynamics of land-origin material in the coastal zone		
A03	Utilization of land-origin nutrients by coastal ecosystem		
A04	Land-coastal zone-open ocean exchange of freshwater and material		
B01	Material exchange between the coastal zone and the subpolar ocean	2	10
B02	Material exchange between the coastal zone and the Kuroshio region		
B03	Inverse modeling for coastal zone-open ocean interaction		
C01	Terrestrial material dynamics and its influence on the ocean		

Research Outline of Research Areas

The past, present, and future of "misbehaving climate" and humans
https://www.ritsumei.ac.jp/research/abbarel/

Abbreviated Name of Research Area		Misbehaving Climate and Humans
Number of Research Area	:	24A101 Term of Project : FY2024-2028
Head Investigator	:	NAKAGAWA Takeshi
Research Institution	:	Ritsumeikan University ·Research Centre for Palaeoclimatology

1. Details of Research Area

Climate has three dynamic modes. The first is gradual 'climate change', such as so-called global warming. The second is 'extreme events', such as rare torrential rainfall. The third is a phenomenon in which the climate becomes persistently unstable and 'hazards' become more frequent. In this research area, we call this third mode 'misbehaving climate'. International organisations have reported that increased frequency of weather disaster have caused losses of millions of lives and several hundred trillion yen over the last few decades.

The project aims at reconstructing when in the past the climate was 'misbehaving' by analysing 'varves' (= annually layered sediments). Archaeological methods are then used to examine the temporal relationships between past 'misbehaving climate' and human history. We will also develop next-generation methods of age determination. By introducing climate modelling and disaster scenario analysis methods, the project aims to examine the mechanisms of 'misbehaving climate', its impact on human society, and to make effective countermeasures and recommendations for the future.

2. Call for Proposals

This research area consists of six research groups: A01 (chronology), A02 (palaeoclimate), B01 (Japanese archaeology), B02 (Maya archaeology and history), C01 (climate modelling) and C02 (impact and adaptation). In FY2024, calls for publicly offered research will be made by A02, B01, B02 and C02 groups.

A02 (Paleoclimate) invites applications for research to reconstruct the pattern and frequency of terrestrial disasters (e.g. wildfires and floods) by analysing existing varve samples such as those from Lake Suigetsu (samples will be provided). In order to correctly assess the impact of disasters on human history, the data density must be high enough to resolve 'human time scales' (several years to several decades). We look forward to applications from those willing to take on this challenge.

B01 (Japanese Archaeology) invites applications for archaeological research that examines whether there is a correlation between environmental change and human activities in any period from the Palaeolithic to the Yayoi period, using data on climate change recorded in the varved sediments of Lake Suigetsu, volcanic disasters and so on. In particular, we look forward to research that aims at examining the relationship between the coldest period of the Last Glacial Maximum, the rapid warming of the post-glacial period, the cooling of the Jomon period and after the Jomon sea advance, and human activities.

B02 (Maya Archaeology and History) invites applications for research related to archaeology, history and cultural anthropology, extending the perspective of 'misbehaving climate' to the Maya and other regions in Mesoamerica. The maximum limit for applications is 3 million yen per year for research requiring significant expenditure, such as excavations, and 2 million yen per year for other researches. We expect proposals to contribute to the diachronic study of the history of environment and civilisations in Mesoamerica, focusing on archaeology, public archaeology, environmental archaeology, zooarchaeology, archaeological sciences, history on colonial and modern times, and cultural anthropology on contemporary indigenous cultures.

C02 (Impacts and Adaptation) invites applications for following researches: 1) research on the social implementation of adaptation measures to the 'misbehaving climate' through policy scientific analysis of disaster prevention, mitigation measures, and land use policies; 2) research on the psychological basis of adaptation efforts and evacuation behaviour, etc., through analysis of the risk perception of the general public and administrative officials towards water-related disaster risks posed by the 'misbehaving climate'; and (iii) predictive assessment of the impact of a 'misbehaving climate' on the agriculture, forestry, fisheries and health sectors, as well as adaptation to it. We welcome research that will actively issue proposals to society.

3. Research Group, Upper Limit of Annual Budget and Number of research projects scheduled to be selected

Research Group Number	Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A02	Reconstruction of the climatic stability/instability and tempo of disasters using varves.	2.5	2
B01	Correlation between climate change and human activities in Palaeolithic and Jomon periods		
B02	Collaboration with Mesoamerican archaeology, history and cultural anthropology	Excavation 3.0 Others 2.0	1 2
C02	The policy science of land use and disaster response in an era of 'misbehaving' climate	5.0	2
	Changing perceptions on the risk of water-related disasters posed by a 'Misbehaving Climate'		
	Impacts and adaptation of a 'Misbehaving Climate' on the agriculture, forestry, fisheries or health	7.0	2

Research Outline of Research Areas

Materia-Mind: Constructing a New Human Historical Science of the Co-creation of Material and Mind
http://materiamind.ridc.okayama-u.ac.jp

Number of Research Area	:	24A102	Term of Project :	FY2024-2028
Head Investigator	:	MATSUMOTO Naoko		
Research Institution	:	Research Institute for the Dynamics of Civilizations		

1. Details of Research Area

A crucial key to human evolution, the formation of civilization, and our future is the co-creative relationship between humans and objects. This Research Area will attempt to elucidate the mechanisms of the intertwining of environmental construction by humans and changes in human cognition, body, and behavior through trans-disciplinary collaborative research that transcends the boundaries of the humanities and sciences, based on quantitative, experimental, and advanced analysis using archaeological data spanning tens of thousands of years. By conceptualizing the state of things as "*materia*" as sensed and experienced by people, we will create a new Research Area that goes beyond the dualism that separates matter and mind in order to focus on materiality as the mother of the mind. From the perspective of the formation of the "*material-mind*," we will clarify how the major shift in cognitive abilities prompted the construction of complex societies or civilizations, a phenomenon unique to humans, pursue the limits and possibilities of human cognitive abilities, and propose a new model for an integrated understanding of where humanity came from and where it is going.

2. Call for Proposals and Expectations for Publicly Offered Research, etc.

We aim to achieve the integration of related fields essential to elucidate the mutually constructed relationship between material, mind, and body and to create a new view of human beings, culture, and history. We seek empirical and theoretical research that complements and reinforces the following research groups and introduces new perspectives. A01: Case studies and innovative theoretical and methodological research centered on archaeology, anthropology, and other humanities and social science fields on the relationship between "technological innovation," "dynamics in arts and social complexity," and related "cognitive processes" in human history. The geographic area of study is not restricted. A02: Archaeology, natural geography, cultural anthropology, history, and other related areas that focus on ecological and social changes interconnected with natural disasters, migration, technological innovation, and cross-cultural contact. B01: Research on the relationship between the transformation of natural ecological environments and cultural landscapes and human activities and their historical changes, using GIS and remote sensing, etc.; research on the cognitive structures of people living in local societies and their transformations through ethnographic research. B02: Cognitive scientific research that explores the causal relationship between creative artifacts, songs, music, and other artistic expression and environment, cognition, and individual characteristics (cognitive archaeology, cross-cultural comparison, developmental and animal studies, statistical causal modeling research, etc.). C01: Genetic, neurophysiological, cognitive, and behavioral studies in humans and non-human animals on the interaction between genes and the social environment. Studies that contribute to the construction of theoretical models are also welcome.C02: Research on innovative analytical methods related to 3D data or the construction of evolutionary models based on 3D data. Publicly Offered Research will be assigned to the most closely related Research Group, but we also encourage active collaboration and joint research with other Research Groups.

3. Research Group, Upper Limit of Annual Budget and Number of research projects scheduled to be selected

Research Group Number	Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A01	Mutual Construction of Objects and Humans: Empirical and Theoretical Study of the Materia-Mind (Material & Mind Group)		
A02	Diachronic Studies of Entanglement and Enchainment between Environment and Humans through Interdisciplinary Fieldworks across the Pan-Pacific (Human & Environment Group)	1.5	4
B01	Elucidation of the "Cultural Evolution" Mechanism of Cognitive Behaviors in Human History through Ethnographic Studies (Behavior & System Group)	2	8
B02	Collaboration between Cognitive Science and Human History to Elucidate the Process of Creative Artifact Creation (Art & Emotion Group)	3	2
C01	Construction of a Materiamind Evolution Model Integrating Life Science and Material Cultural Studies (Genes & Culture group)	4.3	3
C02	Exploring Cultural Evolutionary Dynamics via Multi-Dimentional Representation and Modeling of Archaeological and Anthropological Data (Representation & Modeling Group)		

Research Outline of Research Areas

Ion Jamology: Materials design transformation by understanding non-equilibrium and collective ion flow
http://ion-jamology.jp

Number of Research Area	:	24A201	Term of Project :	FY2024-2028
Head Investigator	:	HITOSUGI Taro		
Research Institution	:	The University of Tokyo		

1. Details of Research Area

Ion jamology reveals the collective motion of ions in solids and develops new materials. In this Research Area, researchers in **materials science and mathematical science collaborate to establish material design guidelines for controlling the flow of ions.** Furthermore, we aim to advance mathematical sciences by tackling new challenges in modeling theories. We are developing high-performance batteries, catalytic materials, and hydrogen storage materials that will contribute to a carbon-neutral society.

We focus on jamology, which exemplifies the application of mathematical science. We employ mathematical models for particle interactions, such as the asymmetric simple exclusion process (ASEP) and cellular automata. We also apply principles of non-equilibrium statistical physics, e.g., jamming transitions, to gain insights into materials and promote the application of mathematical science to a wide range of fields in materials science. The initial step involves integrating this knowledge with research on batteries, catalytic materials, and hydrogen storage materials.

We are advancing three projects to foster this interdisciplinary research. We aim to promote mutual understanding of Planned Research A01, A02, and A03 through these projects.

1. Collective flow of ions (micro to mesoscale)
2. Pathway networks (meso and macroscale)
3. Overall optimization (connecting micro to macroscale)

2. Call for Proposals and Expectations for Publicly Offered Research, etc.

- Researchers pursuing experimental research are *not* necessarily required to incorporate mathematical sciences at the application stage. We expect proposals that elucidate issues involving the collective motion of ions in fields such as batteries, ionics, catalysis, and hydrogen storage. Finally, we seek research topics that will contribute to establishing ion jamology through modeling and quantitative verification.
- Researchers in the mathematical sciences are encouraged to explain the relationship between mathematics and ionic flow in ways that are understandable to experimentalists. Research proposals based on materials simulations are also welcome.

We look forward to receiving the following proposals.

A01・Computation and Mathematics: Research on applying mathematical sciences, represented by materials simulation, graph theory/discrete geometry, statistical machine learning, stochastic processes, etc. We strongly hope for many applications from mathematical scientists interested in materials science.

A02・Materials Synthesis: (a) Synthesis of model materials to obtain precise physical properties and structural information, (b) Development of batteries, solid catalysts, and hydrogen storage materials using new synthesis methods, (c) Development of composite materials by controlling hierarchical structures such as bulk, surfaces, and interfaces.

A03・Advanced Measurements: Measure collective ionic motion in solid ionic conductors, battery materials, catalysts, and hydrogen storage materials. For instance, (a) Development of *operando* measurement techniques for clarifying ionic, electronic, and lattice interactions, (b) Advanced measurements to complement planned research, (c) Development of measurement and analysis infrastructures.

We expect proposals that actively promote joint research. We also welcome applications from young researchers enthusiastic about exploring new fields.

3. Research Group, Upper Limit of Annual Budget, and Number of research projects scheduled to be selected

Research Group Number	Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A01	Mathematical and computational simulation analysis for the construction of ion jamology	300	5
A02	Creation of new materials and development of new functions based on ion jamology	400	5
A03	Advanced measurements to elucidate ion jamology	400	5

Research Outline of Research Areas

Integrated Science of Synthesis by Chemical Structure Reprogramming
https://srep.kuchem.kyoto-u.ac.jp/

Number of Research Area	:	24A202	Term of Project :	FY2024-2028
Head Investigator	:	TOBISU Mamoru		
Research Institution	:	Osaka University, Graduate School of Engineering		

1. Details of Research Area

This research area aims to pioneer the innovative concept of **Chemical Structure Reprogramming (SReP)** as a new paradigm-shifting approach to crafting intricate substances. SReP is defined as methodological framework facilitating the modification of molecular architectures by substitution, insertion, or elimination of atom(s) on demand. The implementation of SReP holds promise of streamlining the synthesis of diverse chemical structures, which circumvents the tedious processes of traditional synthesis, and unlocks avenues to previously inaccessible molecular configurations. Within this research domain, we aim to advance and refine SReP methodologies through interdisciplinary collaboration spanning organic chemistry, inorganic chemistry, polymer chemistry, and supramolecular chemistry.

2. Call for Proposals and Expectations for Publicly Offered Research, etc.

This research area seeks to forge a SReP methodology by fostering collaborative endeavors among researchers specializing in diverse domains: organic chemistry (A01), inorganic chemistry (A02), macromolecular chemistry (A03), and physical chemistry (A04). To reshape the landscape of synthetic science without the constraints of conventional academic boundaries, we invite publicly offered research from multifaceted backgrounds. We invite proposals that offer clear and specific insights into the synthetic methodologies and their innovative contributions to the SReP of target substances. We encourage applicants to propose the distinctive synthetic methods and to elucidate their novelty. Furthermore, recognizing the transformative potential of collaborative synergy, we urge researchers to include feasible collaboration avenues with peers in related fields.

The objective of **Group A01** is to pioneer SReP methodologies tailored to organic molecules. We invite proposals aimed at innovating new reactions that challenge the confines of conventional organic synthesis. These may include skeletal editing via elimination, insertion, or substitution of atom(s), isomerization and rearrangement of molecular skeleton, epimerization independent of thermodynamics, isotope labeling of molecular skeleton, among others. We welcome diverse approaches to realizing the SReP method, which spans homogeneous or heterogeneous catalysis, photochemical reactions, electrochemical reactions, and beyond.

Group A02 is dedicated to advancing SReP methodologies tailored to inorganic materials, encompassing metal complexes, metal clusters/nanoparticles, and oxide clusters. We seek proposals that confront the longstanding challenge of precisely controlling metal species, geometric arrangements, and nucleus numbers, which would enable post-synthesis editing of inorganic materials. We particularly encourage proposals exploring SReP methods grounded in molecular chemical approaches, which are poised for collaboration with Group A01.

Group A03 is tasked with pioneering SReP methodologies tailored to a diverse array of macromolecular groups, spanning proteins, nucleic acids, sugars, biopolymers, synthetic polymers, coordination polymers, supramolecules, and two-dimensional layered materials. While conventional methods like the click reaction enable modification of macromolecules at their terminal site and their side chains, we invite proposals focused on substructural transformations of the macromolecular backbone itself—a challenge often elusive to traditional approaches.

Group A04 serves as a catalyst for the advancement of SReP within Groups A01-A03, leveraging cutting-edge measurement techniques, analyses, and simulations. We encourage proposals aimed at unraveling the intricate chemical structures and reaction mechanisms of newly developed SReP methods through the application of innovative physicochemical methods. This includes but is not limited to, time-resolved spectroscopic measurements (e.g., XAFS), large-scale quantum chemical calculations, high-resolution TEM imaging, advanced measurements (e.g., STM), and catalyst design utilizing informatics.

3. Research Group, Upper Limit of Annual Budget and Number of research projects scheduled to be selected

Research Group Number	Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A01	Organic Chemistry Group	2.5	11
A02	Inorganic Chemistry Group		8
A03	Macromolecular Chemistry Group		5
A04	Physical Chemistry Group		4

Research Outline of Research Areas

Habitable Japan: Sustainability of atmospheric and oceanic enviromnent as a survival basis of island country Japan
http://hotspot3.aori.u-tokyo.ac.jp/en/

Number of Research Area	:	24A203	Term of Project :	FY2024-2028
Head Investigator	:	OKA Eitarou		
Research Institution	:	Atmosphere and Ocean Research Institute, The University of Tokyo		

1. Details of Research Area

Under global warming, in the region surrounding Japan where the ocean warms at twice the global average rate, the Kuroshio large meander and marine heat waves (MHWs) are becoming normal, extreme heat/rainfall and typhoons are intensifying, and marine ecosystems are changing. Will mild climate and abundant water/fisheries resources persist as a basis of survival for those of us living in Japan in the future? To address this question, using state-of-the-art observations and numerical modeling, we will elucidate variations and changes of atmospheric/oceanic (A/O) circulation near Japan that can be sustained through local processes involving interactions of the surrounding ocean/land, but also through remote impacts coming from the tropics and from the Arctic, unveil their influence on extreme/abnormal weather, marine ecosystems, and fisheries resources, and explore the predictability. We will also clarify the impact of A/O variations near Japan on climate over the North Pacific and over the globe. We will further refine processes of heat/material exchanges between the atmosphere and the ocean across the sea surface and biological production/decomposition at the ocean surface. Through these efforts, we will create integrated A/O science and build a foundation for future predictions and projections.

Research Group A01 clarifies variations/changes of ocean currents around Japan and their impact on coastal MHWs and marine ecosystems (A01-1). We conduct shipboard observations in the Japan Sea (Jan. 2026) and in the North Pacific off the Sanriku coast and in the East China Sea southwest of Kyushu (both Jun.-Jul. 2026) to clarify the influence of oceanic fronts and MHWs on atmospheric circulation and rainfall (A01-1/A01-2). We will also be clarifying the mechanism sustaining large-scale A/O heat and cold waves around the East Asia and the North Pacific (A01-3). Research Group A02 will deploy profiling floats around the Kuroshio Extension to clarify biological production/decomposition (A02-4). We will also be conducting continuous observations at an island in the Japan Sea and another in the North Pacific to clarify the influence of aerosol particles generated from wave spray on heat/material exchanges across the sea surface (A02-5). We will additionally be creating a new data assimilation method that overcomes many discontinuities in the A/O fields to reproduce A-O-marine ecosystems coupling processes in the models (A02-6). Research Group A03 will evaluate the predictability of extreme oceanic events such as the Kuroshio large meander and MHWs, and clarify their impact on fisheries resources (A03-7). We will also take on prediction of monsoon modulating under global warming and that of extreme weather such as heavy rainfall/snowfall inherent in monsoon (A03-8). We will also further clarify variability and future change of mid-latitude climate that interact with the tropics and polar regions from a global perspective (A03-9).

2. Call for Proposals and Expectations for Publicly Offered Research, etc.

Publicly Offered Research projects in this Research Area are expected to share the above question with Planned Research projects (A01-1 ~ A03-9), to conduct research in cooperation with one or more of them, and to complement and expand their research, thereby enriching research of the whole Research Area. Preferred themes include 1. Study to clarify mechanisms and make predictions regarding the impact of coastal to global oceanic variations/changes on marine ecosystems including fisheries resources, 2. Study on the influence of large-scale A/O variations on local weather such as the Fehn phenomenon, the Yamase winds, and urban weather, 3. Study on interaction between mid-latitude oceanic/tropospheric variations and stratospheric variations, 4. Study on rainfall over the ocean using satellite, shipboard, and float observations, 5. Observation sharing platforms with Planned Research projects to deepen understanding of basic processes, and 6. Data analysis, parameter estimation, and prediction for the atmosphere and the ocean using data assimilation and machine learning.

To apply results from this Research Area to society, we welcome studies regarding a survival basis on land that is not the direct target of Planned Research projects: 7. Study on the impact of A/O variations and changes on terrestrial resources and needs of human society (hydrology, terrestrial ecosystems, agriculture, health, energy, societal systems, etc.) and its prediction.

We seek to recruit 12 Publicly Offered Research projects. Three projects of up to 9M yen/year will be assumed to conduct observations. (The other nine projects of up to 3M yen/year may also conduct observations.) Applications from early-career and female scientists are strongly encouraged.

3. Research Group, Upper Limit of Annual Budget and Number of research projects scheduled to be selected

Research Group Number	Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A01	Understanding of mid-latitude A/O variability under global warming	9	3
A02	Development of new methods and identification of basic processes	3	9
A03	Prediction and sustainability evaluation of mid-latitude A/O variability		

Research Outline of Research Areas

Chimera Quasiparticles for Novel Condensed-Matter Science
https://chimera-qp.ee.es.osaka-u.ac.jp

Number of Research Area	:	24A204	Term of Project :	FY2024-2028
Head Investigator	:	MURAKAMI Shuichi		
Research Institution	:	Department of Physics, Tokyo Institute of Technology		

1. Details of Research Area

The discovery of various "quasiparticles" (quantum mechanical entities that behave like particles in matter) is one of the most important achievements in condensed matter physics, which has enabled us to understand complex physical phenomena in terms of a small number of quasiparticles. Phenomena related to crystal vibration, light, magnetism, polarization, and plasma can be described by phonons, photons, magnons, polaritons, and plasmons, respectively. If we can create a new species by combining various quasiparticles, we can freely realize desired physical properties and functions, which will bring about new developments in materials science. However, in most cases, quasiparticles behave independently due to differences in time and space scales. In this Research Area, we will create "chimeras" (hybrids) by "chemical reactions" between quasiparticles that have been studied independently, by introducing various schemes such as artificial structures, material design, and symmetry design, and clarify physical properties and functions of chimera quasiparticles. This will revolutionize the basis of physical properties research and form a new foundation for the realization of highly functional electronic, optical, quantum, and energy devices. The goal of this research field is to establish chimera quasiparticle science. Chimera quasiparticle science will drastically increase the number of combinations of quasiparticles, and enable the transfer of the properties of a single quasiparticle to another quasiparticle and the response of different physical quantities to an external field (cross response), which will enable discoveries and proposals of new physical phenomena that cannot occur with a single quasiparticle.

2. Call for Proposals and Expectations for Publicly Offered Research, etc.

We are widely inviting research plans that contribute to the construction of chimera quasiparticle science as Publicly Offered Research. We ask that research plans include an explanation of how the plan will contribute to the objectives of the Research Area. We will not limit our research to the fields of the Planned Research, but will call for proposals from a wide range of fields. The main fields of research that are envisioned are: condensed matter physics, materials engineering, electrical and electronic engineering, nano-micro science, applied physical properties, applied physical engineering, physical chemistry, organic chemistry, polymer organic materials, inorganic materials science, information science, information engineering, and many more. We aim to broaden the scope of this research area through collaboration among different fields.
In addition, we welcome challenging proposals based on novel and original ideas. We also actively invite research that is complementary to the Planned Research, that promotes collaboration between research groups, and that spans multiple research groups. We also hope that active exchanges and discussions with researchers in the Research Area during the research period will lead to new research ideas that were not anticipated even at the time of application.
The Planned Research in this research area consists of five Research Groups listed below, and the Publicly Offered Research will belong to one of these five groups. However, this does not limit the content of the Publicly Offered Research. If it is difficult to decide which research item number your proposal belongs to, please tentatively specify one of the research item numbers.
Group A01: Propose a new theory of chimera quasiparticles, and provide interpretations and proposals to experiments.
Group B01: Explore the possibility of metamaterials as reaction fields for the generation of chimera quasiparticles.
Group B02: Investigate physics of chimera quasiparticles, in particular transport properties and kinetics.
Group B03: Conduct chimera quasiparticle science utilizing the properties of molecules and interfaces in molecular science.
Group C01: Elucidate the functionality of chimera quasiparticles from the viewpoint of electronics applications.
We call for experimental research with a larger budget (up to 3 million yen per year), as well as small-scale experimental, theoretical, and preparatory research based on new and original ideas with a small budget (up to 2 million yen per year).

3. Research Group, Upper Limit of Annual Budget and Number of research projects scheduled to be selected

Research Group Number	Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A01	Chimera Quasiparticles: Theory	3	11
B01	Chimera Quasiparticles: Architecture	2	11
B02	Chimera Quasiparticles: Physics		
B03	Chimera Quasiparticles: Molecular Science		
C01	Chimera Quasiparticles: Electronics		

Research Outline of Research Areas

Investigation on the Origin and Evolution of Matter in the Universe by Extremely Rare Events: Frontier of Creating a New Insight on the Matter in the Universe
https://www.lowbg.org/ugrp/

Number of Research Area : 24A205 Term of Project : FY2024-2028
Head Investigator : KISHIMOTO Yasuhiro
Research Institution : Tohoku University, Research Center for Neutrino Science

1. Details of Research Area

The universe has evolved from the high-temperature, high-density state to the present status. In this evolving universe, only a little is known about the origin of matter and its evolution: "Why there is no antimatter but only matter?", "What is the nature of dark matter?", "How heavy elements were created and diffused?". Thus, the origin of the matter in front of us remains completely unrevealed.

In this research area, we will elucidate these fundamental mysteries about the origin of matter by searching for extremely rare events, such as neutrino-less double beta decay, dark matter, and supernova neutrinos. Through exploration of the mysteries, we aim to gain new knowledge about matter and to gain a new insight on matter.

2. Call for Proposals and Expectations for Publicly Offered Research, etc.

The goal of this research area is to conduct fundamental research on the mysteries mentioned above and to turn them into a consistent understanding throughout the history of the universe. Toward this goal, we will promote the investigations on Majorana nature of neutrino, the dark matter, and neutrino from supernovae and astronomical objects based on "extremely rare event technology (ERET)", and construct physics model behind them. ERET is a common foundation to detect extremely rare events. It is necessary to deepen and develop the technology for current and future experiments. Introduction and dissemination of the technology is also one of the main objectives of the research area. We welcome research proposals related to the technology.

We expect Publicly Offered Research proposals to collaborate with each Planned Research, to strengthen collaboration, and ones that was not covered in Planned Research: (1) Experimental research utilizing existing ERET (e.g., extremely low radiation environment and high sensitive measurements), (2) Aiming to expand and develop ERET, (3) Studies to improve the accuracy of relevant physical quantities and model calculations, including machine learning, (4) Research aiming at collaboration to related research areas, and (5) R&D aiming at expansion of theoretical research, cross-field and application. A representative of the relevant Planned Research will be assigned as a contact person to successful applicant. We expect active applications from those who are motivated to further activate the field through active discussions and joint research. In the case of research that encompasses multiple research items, the most closely related research item will be selected

3. Research Group, Upper Limit of Annual Budget and Number of research projects scheduled to be selected

Research Group Number	Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A01	Exploring the origin of matter in the universe with large liquid scintillator detector	Large scale experimental and theoretical research 4.50	2
A02	Development of the double beta decay detector to search for Majorana neutrinos		
B01	Frontier of dark matter axion search opened up by technologies on strong magnetic field, microwave and superconducting device	Experimental and relatively large-scale theoretical research 3.70	4
B02	Exploring the nature of dark matter with a large liquid xenon detector		
B03	Direction sensitive dark matter search with high precision tracking technologies		
C01	Frontier of Rare Events in the Universe: Investigating the Origin of Elements in the Universe with the Universal Supernova Neutrino Detector	Theoretical studies, small-scale experimental research 1.50	10
D01	Deployment of ultra-low radioactivity techniques		
E01	Theoretical research on the origin of matter and the evolution of the universe		
E02	Theoretical study of supernova neutrinos using all neutrino flavors		

Research Outline of Research Areas

Plasma-driven Seed Memory Operation: Frontier in Molecular Dynamics in Seeds driven by Plasma
https://plasma.ed.kyushu-u.ac.jp/plasma-seed-science/en/

Number of Research Area	:	24A206	Term of Project :	FY2024-2028
Head Investigator	:	KOGA Kazunori		
Research Institution	:	Kyushu University, Faculty of Information Science and Electrical Engineering		

1. Details of Research Area

Plants have difficulty moving from where they are rooted, so they have a high adaptive capacity to climate change. They are stored as a memory in the DNA modification of seeds and passed on to the next generation. Parental generations stressed by high temperatures result in the deteriorated quality of seeds. Low-temperature plasma converts external electrical energy into electron kinetic energy, producing light, ions, and chemically active molecules (reactive species) through electron collision with atoms/molecules. It has attracted much attention because of its ability to irradiate reactive species at high flux without damage. So far, we have found that three minutes of air plasma irradiation to seeds can recover the damage caused by high temperature through alteration in the DNA methylation that turns gene expression on and off. These results suggest that plasma irradiation for a short time scale can selectively modify memories stored in seeds.

To clarify this mechanism, three research groups were set up: A01 'plasma', A02 'seeds', and A03 'omics'. We will build physical and chemical reaction network models to to elucidate the molecular mechanism of DNA modification induced by plasma irradiation. The established field of "plasma seed science" aims to manipulate the plant memories that underlie seeds through plasma treatment.

2. Call for Proposals and Expectations for Publicly Offered Research, etc.

The following describes the research groups and expectations for the publicly offered research established in plasma seed science.

[A01 'Plasma' Group: Science to a selective generation of reactive species]

In this research area, plasma irradiation in a wide gas pressure range from low to atmospheric pressure is being investigated. Research group A01 'Plasma' aims to improve reproducibility in plasma irradiation of seeds and to realize selective irradiation of active species and localized irradiation to seeds. To achieve this objective, it is essential to understand the physics and chemistry of complex molecular gas discharges. The publicly offered research is expected to contribute to creating new principles for controlling reactive species synthesis, gas-phase measurement to clarify the details of electron behavior and reactive species generation in plasmas, and a wide range of analysis using computational ~~science~~ approaches.

[A02 'Seed' Group: Science to deliver reactive species inside seeds]

Research group A02 'seeds' aims to understand and control physical and chemical processes and plasma-driven molecular transport from the seed coat to the cytoplasm through the cell wall and cell membrane. The expected publicly offered research includes new innovative measurements, analysis, and theoretical modeling to clarify molecular transport with chemical reactions from the seed surface to the inside of the cell and molecular biological studies to analyze each seed tissue. In addition, studies of model plants for a better understanding of the role of reactive species in intercellular signal transduction and molecular transport are also welcome.

[A03 'Omics' Group: Science to apply reactive species to DNA modification]

Research group A03 'omics' aims to create a foundation for seed memory manipulation based on understanding omics variation from DNA modification-related molecular mechanisms to phenotypes caused by plasma irradiation. The expected publicly offered research includes developing physical models of plasma-induced DNA modification using atomic and molecular simulations and bioinformatics research to construct an integrated chemical reaction network by connecting DNA modification-related transomics and chemical reaction networks in plasma. In addition, ~~research~~ to discover new molecular dynamics in transomics and to investigate the growth-promoting effects of plasma irradiation other than changes in DNA modifications are also welcome.

3. Research Group, Upper Limit of Annual Budget and Number of research projects scheduled to be selected

Research Group Number	Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A01	Plasma: Science to selective generation of reactive species	3	18
A02	Seed: Science to deliver reactive species inside seeds		
A03	Omics: Science to apply reactive species to DNA modification		

Research Outline of Research Areas

Generative Design to Unlock the Potential of Protein Function
https://p-func.kuchem.kyoto-u.ac.jp

Number of Research Area	:	24A207	Term of Project :	FY2024-2028
Head Investigator	:	HAYASHI Shigehiko		
Research Institution	:	Kyoto University, Graduate School of Science		

1. Details of Research Area

We aim at establishing design principles that enable conversion and creation of the molecular functions of proteins in a generative manner. To exploit the high potential of protein molecular functions, a methodology for molecular design of protein functions that follows given requirement definitions of the novel functions will be developed. To this end, more universal physicochemical approaches which are not constrained by evolutionary information are introduced. Namely, the transiently formed functional states that determine molecular functions are directly observed and analyzed by physicochemical approaches, and then the novel functions are designed based on the molecular understanding. A new field of research will be created by integration of theoretical predictions based on molecular simulations and data science, state-of-the-art spatiotemporal measurements such as time-resolved X-ray crystallography and spectroscopy, and creation of protein molecules through biochemistry and protein engineering. The development of novel functional proteins such as biomedical tools and useful enzymes will be demonstrated. Furthermore, the functional design scheme will be applied to artificial de novo proteins that do not exist in nature to endow them with completely novel molecular functions.

2. Call for Proposals and Expectations for Publicly Offered Research, etc.

Proposals for Publicly Offered Research using a variety of theoretical and experimental physicochemical techniques are actively invited. In addition, complementary research proposals without a strong physicochemical basis, such as machine learning and directed evolution experiments, are also welcome. Proposals for research on molecular evolution toward the functional design are also welcome. Details of the research proposals of each research group are described below.

A01: Functional analyses and molecular design by computational chemistry. A02: Molecular design by data-driven approaches such as data assimilation and machine learning. A03: Protein design with theoretical and experimental de novo protein design techniques. B01: Measurement and technical development of time resolved structural biology. B02: Spaciotemporal measurements by biophysical techniques such as spectroscopy, high-speed AFM, NMR, HDX-MS, and single molecule observations. B03: Protein functional design by structural biology techniques such as X-ray crystallography, Cryo EM, and NMR. C01: Chemogenetics studies such as development of designer ligands. C02: Protein design by regulation of protein-protein interactions. Investigation of intrinsically disordered protein regions is also included. C03: Design of novel reporter and sensor proteins for cell state visualization. C04: Protein design of optogenetics and photo-manipulation tools. C05: Protein design of useful enzymes. Synthetic chemistry for development of caged compounds is also included. Proposals for interdisciplinary research with synthetic chemistry and complex chemistry in which chemically synthesized highly functional catalysts or complex molecules are combined with proteins, are also welcome. For research of Group B, how the elucidation of the functional state can contribute to the functional design should be considered. For research of Group C, not only what prominent features can be obtained, but also how to obtain them should be considered.

To encourage participation of diverse researchers, proposals for research plans with high efficiency that guarantee a good work-life balance are welcome.

3. Research Group, Upper Limit of Annual Budget and Number of research projects scheduled to be selected

Research Group Number	Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A01	Functional analysis and design by computational chemistry	3	7
A02	Functional analysis and design by data-driven science		
A03	Theoretical and experimental design of functional de novo proteins		
B01	Measurement and development of time resolved structural biology		6
B02	Spaciotemporal measurements by biophysical techniques		
B03	Protein functional design by structural biology techniques		
C01	Experimental creation of tool proteins for chemogenetics		9
C02	Experimental creation for regulation of protein-protein interactions		
C03	Experimental creation of sensor proteins for cell visualization		
C04	Experimental creation of tool proteins for optogenetics		
C05	Experimental creation of useful enzymes		

Research Outline of Research Areas

Manipulating Genomes of Intracellular Symbiotic Organelles: Advancements in Technology, Applications for Fundamental Sciences, and Beyond.

https://www.agr.kyushu-u.ac.jp/cytoplasmicgenomeregulation/

Number of Research Area : 24A301 Term of Project : FY2024-2028
Head Investigator : ARIMURA Shin-ichi
Research Institution : University of Tokyo, Graduate School of Agricultural and Life Sciences

1. Details of Research Area

Endosymbiotic bacteria and their derived mitochondria and chloroplasts have their own internal genomes (cytoplasmic genomes). These are involved in fundamental life processes such as respiration, cell death, sex determination and photosynthesis, but the difficulty of genome modification has hindered their understanding and application. Our team is at the forefront of successful genome editing and gene transfer of plant organelles. These technologies will be utilized to carry out 'Research group A01: Development of freely available cytoplasmic genome regulation technology with expanded target organisms', 'Research group B01: Full understanding of the molecular basis of cytoplasmic genome behavior (maintenance, dynamics and expression)' and 'Research group B02: Elucidation of critical life processes in which cytoplasmic genomes are pivotal and challenge to their application'. Our overarching research aim is to make a quantum leap in every aspect of "technology, science, and application" in organelle biology.

2. Call for Proposals and Expectations for Publicly Offered Research, etc.

This research area is open to organisms with symbiotic organelles, i.e. all eukaryotes, and we welcome research from a wide range of species, perspectives and disciplines. Not only mitochondria and chloroplasts, but also host-bacteria combinations that have an absolute symbiotic relationship within the cell are eligible. The implementation of openly proposed research will be supported by the research support team (genome editing, gene transfer, single organelle analysis, respiratory physiological activity measurement, photosynthesis and respiratory activity measurement, bioinformatics, protein structure analysis). Through the use of this support, it is expected that joint research with the planned research teams will be promoted and that inter-disciplinary joint research will be strongly promoted.

Under research group A01, new technology development and technology licensing targeting cytoplasmic genomes will be carried out (key words: 'genome editing', 'molecular delivery', 'gene transfer', 'selection', 'mutation creation', etc.). Along with proposals aimed at solving the problems of rate-limiting elements in the areas of genome editing, drug delivery and genetic recombination, proposals for completely new approaches will also be accepted, with the expectation that they will contribute to the development of this research area. Research group B01 promotes basic research on the "genetics" of cytoplasmic genomes, including replication, dynamics, distribution, transmission, inheritance, repair, elimination, expression mechanisms and epigenetics of cytoplasmic genomes and nucleoids. We expect proposals for open research that combines "research to elucidate the mechanisms of maintenance and functional expression of cytoplasmic genomes themselves" and "research to investigate their physiological functions at the organelle, cellular and individual levels" (keywords: "gene expression", "maternal inheritance", "heteroplasmy" etc.) in a variety of organism species. Research group B02 is a study that includes both basic and applied research on phenotypic traits caused by the cytoplasmic genome and traits with large spillover effects on human society (keywords: 'mitochondrial diseases', 'photosynthesis', 'sex differentiation/regulation', 'male sterility', 'high functionality', etc.). In many diseases with mitochondrial dysfunction, efforts are expected to target their genomes for analysis, control and disease treatment. Applied research oriented towards the SDGs through cytoplasmic genome regulation is also expected.

The amount of applications is 15 for a single year of 3.5 million yen, with two types of application items: 'A01 control technology' and 'B01 and B02 genetic understanding and utilization development'. As we believe that one of the objectives that should be tackled with priority and proactively is "the elucidation, application and development of important life processes through the early utilization of previously established cytoplasmic genome editing technologies", we plan to increase the number of applications in the B01 and B02 groups. In order to maximise the interaction and results of the entire field, this field group plans to operate the field in an open manner, allowing participation in field meetings, etc. regardless of whether the research is adopted or not as an open call for research. We also expect active applications from researchers from various backgrounds, including female researchers and young researchers.

3. Research Group, Upper Limit of Annual Budget and Number of research projects scheduled to be selected

Research Group Number	Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A01	Development of cytoplasmic genome regulation technology	3.5	3
B01	Molecular basis of cytoplasmic genome behavior		12
B02	Impact of cytoplasmic genomes on life processes and their applications		

Research Outline of Research Areas

Biological cluster: dynamic assembly and functional properties of supramolecular complexes in cells
https://www.cluster-biology.f.u-tokyo.ac.jp/

Number of Research Area	:	24A302	Term of Project :	FY2024-2028
Head Investigator	:	FUKAGAWA Tatsuo		
Research Institution	:	Osaka University, Graduate School of Frontier Biosciences		

1. Details of Research Area

In cells, protein complexes are clustered to a higher order structure called "supramolecular complexes", which governs various cellular functions. In recent years, with advances in cryo-electron microscopy (EM) techniques, many studies have been conducted to elucidate the structures of molecular complexes reconstituted in vitro, but such studies alone often fail to understand how complexes function in cells. This is because in vitro complexes do not reflect with in vivo supramolecular complexes functioning in cells. In vitro complexes sometimes make a condensate. However, such disordered condensates do not reproduce the organized supramolecular complexes formed in cells. In this Research Area, we define "Biological Clusters" as functional "supramolecular complexes" and aim to clarify their formation mechanisms and functional properties, and understand how they generate cellular functions. The Planned Research will focus on supramolecular complexes constituting kinetochores, centromeres, chromosomes, and centrosomes, but the Publicly Offered Research will not be limited to these but will cover a wide range of supramolecular complexes formed in cells. The research will be conducted by analyzing the ultrastructure and molecular dynamics of supramolecular complexes, measuring physical quantities, and developing theory and computational science. We aim to establish a new cellular view of Biological Clusters by clarifying the mechanisms of formation of various Biological Clusters and the relationship between their acquired properties and cellular functions.

2. Call for Proposals and Expectations for Publicly Offered Research, etc.

Research Group A01 aims to elucidate the molecular basis of various supramolecular complexes, from the structure of their basic units to the regulation of supramolecular complex formation and their cellular functions. The Planned Research will focus on kinetochores, centromeres, chromosomes, and centrosomes, but we welcome research that targets a wide range of important supramolecular complexes, including those involved in transcription, replication, various organelles, and nuclear membrane. Research on supramolecular complexes that function in special environments, such as neurons, aging and stress responses, and diseases, is also eligible.
Research Group A02 focuses on advanced high-precision imaging analysis to solve the structure of supramolecular complexes and elucidate their properties and molecular dynamics. In addition to cryo-ET (electron tomography) and super-resolution imaging, we encourage technologically advanced research for analyzing supramolecular complexes, such as atomic force microscopy, NMR, crosslinked mass spectrometry, deuterium exchange mass spectrometry, development of probes applicable to fluorescence microscopes and new techniques, and methodologies not envisioned in the Planned Research.
In research Group A03, we will measure physical quantities of supramolecular complexes and conduct mathematical analysis parallelly, to elucidate the functional properties of clusters and the elements involved in their formation. In particular, we envision research that attempts to explain complex formation based on simulations that mimic the intracellular environment and research that describes the physical properties of supramolecular complexes. We also welcome research proposals that attempt to demonstrate physical theories that could be applied to cell biology.
Publicly Offered Research proposals are expected to be complementary to the Planned Research and to promote mutually beneficial research through joint research. In the experimental field, research up to 5 million yen per year and exploratory research up to 3 million yen per year will be selected. Theoretical research up to 3 million yen per year is also selected.

3. Research Group, Upper Limit of Annual Budget and Number of research projects scheduled to be selected

Research Group Number	Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A01	Elucidation of the molecular basis of Biological Clusters and their relationship to cellular functions	Experimental study: 5 Exploratory experimental or theoretical study: 3	10 7
A02	Visualization of Biological Clusters and their molecular dynamics		
A03	Formation and characterization of Biological Clusters by physical and mathematical analysis		

Research Outline of Research Areas

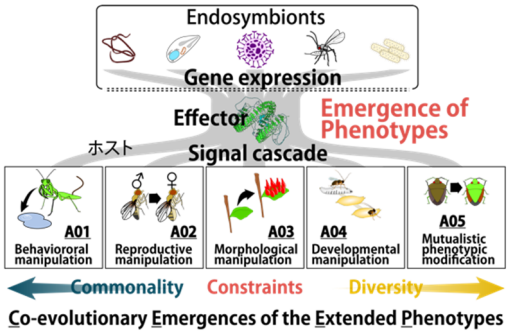
Co-evolutionary emergence of extended phenotypes
http://www.extended-phenotype.org/english/

Number of Research Area	:	24A303	Term of Project :	FY2024-2028
Head Investigator	:	KATSUMA Susumu		
Research Institution	:	The University of Tokyo, Graduate School of Agricultural and Life Sciences		

1. Details of Research Area

Conventional biology generally assumes that phenotypes (such as body shape and behavior) of an individual organism are determined by its own genetic information. On the other hand, there are many interesting phenomena in nature in which the genetic information of one organism can manipulate the phenotypes of different organisms. For example, a praying mantis parasitized by a hairworm jumps into the water, or a lepidopteran insect larva infected with a baculovirus climbs to the top of the tree; these are examples of parasites or viruses manipulating the behavior of the host for their benefit. The phenomenon, called "Extended Phenotypes," proposed by Richard Dawkins, should be realized through interactions between the operating and manipulated organisms based on their mutual genetic information across species. However, the molecular mechanisms underlying these phenomena are poorly understood. This Research Area will focus on the molecular mechanisms of "Extended Phenotypes" hidden in the interactions between various organisms. We will elucidate the delicate and diverse mechanisms of phenotypic regulation that are difficult to access through conventional biology. Overall, we aim to establish a new academic field called "co-evolutionary molecular developmental ecology" that spans from the micro to the macro.

2. Call for Proposals and Expectations for Publicly Offered Research, etc.



"Extended phenotypes," which are the phenotypes created in another organism by the genetic information of one organism, have been attractive to not only scientists but also the general public, and there have been many reports on this phenomenon for a long time. However, many of these phenomena are observed in non-model organisms that are not amenable to molecular-level research, making it difficult to investigate the molecular mechanisms. In this Research Area on endosymbiont-induced "Extended Phenotypes," we aim to (1) identify effectors derived from endosymbionts, (2) identify host signaling pathways, and (3) elucidate the emergence of novel phenotypes. Research Groups fall into five categories: A01. Behavioral manipulation, A02. Reproductive manipulation, A03. Morphological manipulation, A04. Developmental manipulation, and A05. Mutualistic phenotypic modification. We call for Publicly Offered Research focused on endosymbiont-induced "Extended Phenotypes." You can submit your application to one of the Research Groups most closely related to your research subject. Research proposals to uncover the molecular mechanisms underlying unique biological phenomena via inter-organism interactions are highly welcome, even if the research subject has not yet been approached through molecular biology or biochemical methods. We also invite research proposals beyond experimental biology, including theoretical and mathematical approaches. Administrative Group is equipped to support foundational techniques for research advancement, such as various omics analyses, genome editing, recombinant protein production, and imaging analysis, with a strong emphasis on molecular biology approaches related to inter-organism interactions in non-model organisms. Collaborations with Planned Research are also encouraged.

In this Research Area, all Planned Research and Publicly Offered Research collaborate to advance 'Trans-Scale Biology,' aiming to create a new academic discipline that extends beyond individual organisms and comprehends the diversity of nature beyond the scope of conventional biology. We welcome applications from researchers who share this concept and are willing to promote it alongside Planned Research. Additionally, we enthusiastically encourage proposals from young and female researchers to promote diverse and inclusive science.

3. Research Group, Upper Limit of Annual Budget and Number of research projects scheduled to be selected

Research Group Number	Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A01	Behavioral manipulation	4.5	12
A02	Reproductive manipulation		
A03	Morphological manipulation		
A04	Developmental manipulation		
A05	Mutualistic phenotypic modification		

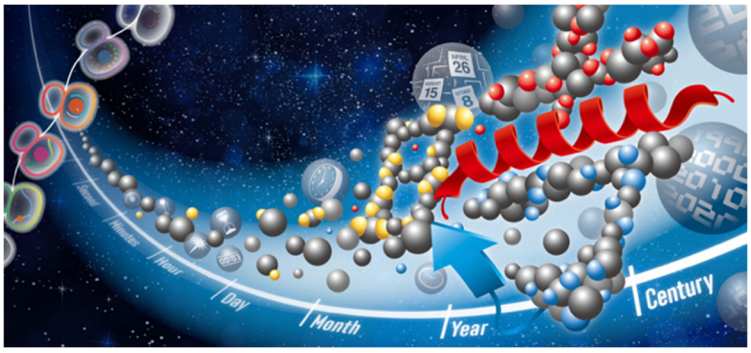
Research Outline of Research Areas

Chronoproteinology: Protein Machinery that drives "time" on various time scales
http://chronoproteinology.org

Number of Research Area	:	24A304	Term of Project :	FY2024-2028
Head Investigator	:	YOSHITANE Hikari		
Research Institution	:	Tokyo Metropolitan Institute of Medical Science		

1. Details of Research Area

The two former transformative research areas (B) "Chrono-Proteinology" and "Parametric Translation" have been combined into the transformative research areas (A) "Chrono-Proteinology". Biological rhythms are observed on different ranges of time scales from seconds to years (or centuries), such as the circadian rhythm with a 24-hour cycle, heartbeat, segmentation clock, seasonal response, and bamboo mass flowering. In this research area, we focus on rhythmic phenomena and timer-like mechanisms and aim to elucidate the molecular mechanisms that count the "times" in various processes. Particular attention is paid to protein dynamics, such as physical properties of specific proteins, enzyme activities, protein-protein interactions, post-translational modifications, conformational changes, and translational controls; given that, we have named this research area "Chrono-Proteinology". Researchers working on this topic across diverse species and a wide range of time scales are welcome to join.



2. Call for Proposals and Expectations for Publicly Offered Research, etc.

Research group A01, " Chrono-Proteinology for circadian rhythms", will understand the molecular mechanisms that count the "time" and determine the 24-hour period in the circadian clockwork. We expect applications to explore the autonomous oscillation mechanism that does not depend on transcription and the period-determining mechanism that counts 24 hours in a temperature-compensatory manner.

Group A02, " Chrono-Proteinology for non-24-hours rhythms", will approach "time" on various time scales from seconds to years (or centuries). We look forward to applications not only for the description of biological rhythms and timers, but also for applications that explore the molecular mechanisms that count "time." We also welcome research proposals that span the A01 and A02 areas and focus on the relationship between 24-hour and non-24-hour rhythms.

Group B01, " Technology for parametric control to decode various "times", aims to develop technologies based on the perspective of "parametric control" developed by Group A03, " Parametric Translation for supporting Chrono-Proteinology". The unique approach of measuring and controlling translation efficiency provides a technical basis for research projects in this area. It is generally accepted that transcription factors and RNA levels determine the amount of protein synthesis. However, recent studies have shown that the protein amount produced from a single copy of RNA is dynamically regulated at the translation level. Considering that clocks counting days and years receive to temporal and seasonal cues from noisy and slowly changing environmental cycles, the translation control can tune the clocks to respond to the cues, as shown by Transformative Research Area (B) "Parametric Translation". We are looking for researchers who will pioneer technologies to decode the "time". The scope of technological development is not limited to quantification and manipulation of translation, but includes imaging techniques, functional analysis of protein structure and properties, information science and mathematical analysis.

Translated with DeepL.com (free version)

3. Research Group, Upper Limit of Annual Budget and Number of research projects scheduled to be selected

Research Group Number	Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A01	Chrono-Proteinology for circadian rhythms	4	6
A02	Chrono-Proteinology for non-24-hours rhythms	4	4
B01	Technology for parametric control to decode various "times	4	6

Research Outline of Research Areas

Emergence of Brain Functions from the Dynamic Connectome
https://plaza.umin.ac.jp/dynamic-brain/

Number of Research Area	:	24A305	Term of Project :	FY2024-2028
Head Investigator	:	IMAI Takeshi		
Research Institution	:	Kyushu University, Graduate School of Medical Sciences		

1. Details of Research Area

The connectome of the brain is not static but continuously changes during development and learning. Brain functions are achieved as "emergent phenomena" by which the information processing is qualitatively altered as a result of the dynamic changes in the connectome. However, the principles underlying these phenomena remain unknown. In this Research Area, we aim to quantitatively and comprehensively understand the dynamic changes in the connectome and the resulting functional changes at the level of neurons and neural circuits. We then use reconstitutive approaches to understand the principles and mathematical laws behind these changes.

2. Call for Proposals and Expectations for Publicly Offered Research, etc.

Many studies have focused on the "elementary processes" of structural changes and functional changes in neural circuits. However, it remains unknown how the structural changes of neuronal circuits as a whole lead to functional changes. In this area, we will use high throughput connectomics technologies to elucidate the relationship between dynamic changes in the connectome and the emergent brain functions. Through quantitative, comprehensive, mathematical, and reconstitutive understanding of connectome and brain function data, we aim to understand the principles that govern emergent brain functions. Therefore, we welcome researchers who have conducted research on neural circuit development, synaptic plasticity, and brain function and behavior.

The Publicly Offered Researchs are expected to take advantage of the various platforms and resources provided by the support teams to advance their own research. Complementary approaches to the Planned Research are highly encouraged.

A01 and A02 will experimentally approach the emergent functions in the brain. Research topics will include dynamic changes of the connectome and functions during postnatal development, learning and plasticity, life events (e.g., pregnancy, birth, and rearing), adaptation to disease, aging, stress, etc. Our Research Area also includes systemic neuronal functions (e.g., visceral sensation and autonomic nervous system) and abnormalities found for neurological and psychiatric disorders. We also welcome research using a variety of model organisms other than the mouse. We strongly encourage studies that combine structural and functional changes of the neuronal circuits. We also welcome challenging approaches and technology development aimed at achieving our research goals.

In A03, we aim to reconstitute emergent brain functions based on the concept of "dynamic connectome". In addition to mathematical approaches at neuronal and circuit scales, our Research Area welcomes pioneering approaches incorporating theory, brain-inspired AI studies, and/or cultured systems.

The Publicly Offered Research with a maximum amount of 5 million yen will be awarded to projects that have already obtained results related to the emergent brain functions based on the dynamic connectome based on comprehensive measurement of brain functions, and are expected to make significant progress by joining this Research Area. The maximum amount of 3 million yen will be awarded to projects that are either novel or challenging, such as research that links (dynamic) connectome and emergent brain functions, or research related to technology development.

For the sake of convenience, the call is divided into the following three categories, but proposals that cross over into other categories are also welcome.

A01 aims to understand emergent functions at the neuronal level focusing on the control of synaptic strength and distribution, the regulation of spontaneous neural activity, and dendritic integration. A02 studies emergent functions at the circuit level, focusing on stepwise circuit reorganization in motor learning, spatial learning, and song learning. In A03, we aim to reconstitute the emergent brain functions using neural organoids and simulations of membrane potentials and molecular activity.

3. Research Group, Upper Limit of Annual Budget and Number of research projects scheduled to be selected

Research Group Number	Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A01	Emergence of neuronal functions	5	7
A02	Emergence of circuit functions	3	14
A03	Reconstitution of emergent brain functions		

Research Outline of Research Areas

Decioherting the epicode of chromatin, which controls cell fate decisions in organisms
https://www.bioreg.kyushu-u.ac.jp/ext/epicode/home-en/

Number of Research Area	:	24A306	Term of Project : FY2024-2028
Head Investigator	:	TACHIBANA Makoto	
Research Institution	:	Graduate School of Frontier Biosciences, Osaka University	

1. Details of Research Area

The aim of this research area is to show that the higher-order structure of chromatin, which was defined by multilayered parameters such as histone modifications, 3D arrangement of genomic DNA, and enhancer-promoter interactions, in other words, the "epigenetic code" (epicode), plays a fundamental role in cell fate determination. By this research activity, we would like to change the role of chromatin from the basis of transcription to a medium for cell fate control.

It has been revealed that chromatin, consisting of DNA and histones, is closely involved in the regulation of gene expression. However, how the changes in the higher-order structure of chromatin during organismal development and cell differentiation control stage-specific gene expression and determine cell differentiation direction is still not well understood. Recently, it has been shown that not only nuclear factors such as DNA-binding proteins but also various external factors such as signals from adjacent cells, hormones, and metabolic products dynamically change chromatin structure. However, research elucidating the relationship between cell differentiation and chromatin structure at the organismal level has not progressed sufficiently due to the limitations of analytical techniques.

Therefore, this research area aims to construct new chromatin analysis technology platforms that dramatically improve comprehensiveness and spatiotemporal resolution, such as live imaging of transcription and histone modifications, single-cell and spatial omics. Using these platforms, we will elucidate the roles of chromatin epicodes in various life events throughout life (nutritional environment response, long-term memory and aging, transgenerational information transmission, early embryo fate). By using diverse model organisms such as mice, zebrafish, fruit fly, and fission yeast, we will explore the universality and specificity of epicodes, and connect them to molecular-level structural analysis and mutant creation through *in vitro* reconstitution. This research area aims to open new horizons in life sciences by elucidating the epicodes of chromatin and clarifying the basis of cell fate determination mechanisms.

2. Call for Proposals and Expectations for Publicly Offered Research, etc.

We expect participation in publicly offered research focusing on life events beyond the scope of the planned research and new methods of chromatin analysis to accelerate the achievement of our goal. We have already selected mice, zebrafish, fruit fly, and fission yeast as model organisms representing mammals, fish, invertebrates, and the simplest eukaryote with chromatin structure. In publicly offered research, to further explore the universality and specificity of epicodes, we welcome proposals targeting various species beyond these models. To elucidate the epicodes throughout the entire life cycle, we welcome proposals not limited to the life phenomena targeted by the planned research. Research proposals aiming to uncover the mechanisms of disease onset, unique life phenomena specific to certain organisms, or advance cutting-edge chromatin structure analysis techniques are welcome. The publicly offered research also aim to identify and nurture the next generation of researchers who will lead the field of epicode research. In this regard, we particularly welcome innovative and challenging research proposals from young researchers. We also emphasize gender equality and especially welcome applications from female researchers. Specific examples of the expected publicly offered research include: 1) Research on organisms not used in the planned research, such as plants or non-model organisms; 2) Research to decipher the epicodes involved in disease onset; 3) Research focusing on nuclear structures not targeted in the planned research; 4) Development of *in situ* chromatin analysis platforms with improved deep-tissue reach and resolution; 5) Research using AI to analyze diverse layers of chromatin structures; 6) Research using mathematical models to simulate cell fate determination by epicodes; 7) Research developing drugs to manipulate epicodes using natural or synthetic compounds; 8) Research aiming to develop or improve live-cell imaging technologies for epicodes; 9) Research developing innovative methods to introduce epicodes into organisms. These examples are not exhaustive, and we look forward to a wide variety of research proposals.

3. Research Group, Upper Limit of Annual Budget and Number of research projects scheduled to be selected

Research Group Number	Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A01	Decioherting the epicode of chromatin, which controls cell fate decisions in organisms	3.8	15

Research Outline of Research Areas

Multicellular Neurobiocomputing: Understanding and Advancing towards Biological Supremacy
https://www.mnbc.riec.tohoku.ac.jp/en/

Number of Research Area	:	24A401	Term of Project :	FY2024-2028
Head Investigator	:	YAMAMOTO Hideaki		
Research Institution	:	Tohoku University, Research Institute of Electrical Communication		

1. Details of Research Area

"Biological supremacy" refers to "the ability of a biologically inspired system to solve a particular problem with learning efficiency, energy efficiency, and adaptability that are difficult to attain with conventional computing." Our brains are composed of bioelements called neurons. Despite their instability, the brain autonomously and adaptively performs advanced computations with high energy efficiency. This property does not manifest in a single cell and cannot be explained by the linear summation of cell properties. Brain functions are generated only when diverse neurons are intricately arranged and wired to form a multicellular network. In this Research Area, we aim to understand the physical substrate of such information processing through experiments on model animals and cultured cells, formulate the observations as mathematical models, and link this information to system applications. Focusing on sensory-motor control, which involves processing sensory inputs and generating time-series signals to control motor outputs, we aim to achieve results that are scientifically universal and technologically impactful.

This Research Area consists of the four Research Groups: Information Science (A01), Bioengineering (A02), Systems Neuroscience (A03), and Hardware Applications (A04). Collaborations between the Groups are organized under the following three domains: (1) Multicellular Modelling, (2) Multicellular Hardware, and (3) Multicellular Wetware. Furthermore, we establish four Shared Platform Centers to accelerate each research and the collaborations between them: the Microfabrication Center, Biomaterials/Open Database Center, Model Animal Experiment Center, and System Implementation Center. Through these efforts, we aim to build a theoretical foundation for information representation and processing in multicellular networks and pursue biological supremacy for future generations of information communication technology.

2. Call for Proposals and Expectations for Publicly Offered Research, etc.

The Publicly Offered Research consists of four groups. The first group is the theoretical and data science group, which will invite proposals on, for example, neural network models and estimation of functional connectivity dynamics based on data-driven modeling; research on biologically-plausible recurrent neural networks and their learning rules; neural data analysis to understand and model multicellular dynamics, including spontaneous activity; software development for general-purpose simulators and remote biological experiments; and machine learning applications of mathematical models. The second group is the bioengineering group, which will invite innovative research proposals related to the manipulation of cultured neurons; brain organoid technology; bioelectronics research for measuring neural activity with high sensitivity and/or ultralow power consumption; and computing and drug discovery applications of cultured neuronal networks. The third group is the biology group, which will invite research on novel topics, including physiological studies on synaptic plasticity and neural circuit development as the neural basis of learning in multicellular systems; research on the functional linkage between the neocortex and subcortical regions; research on behavioral control using diverse types of synaptic transmission; and systems-level studies on multisensory integration and sensory-motor control that can also lead to robot control. Research on multicellular neurobiocomputing using model animals such as nematodes, flies, and zebrafish will also be invited. The fourth group is the hardware group, which will invite wide-ranging research on the implementation of multicellular models on FPGA, ASIC, and analog circuits; device and material research for model implementation; physical reservoir applications; applications to autonomous control of robots; and control of external devices based on neural activity at the cellular level. Finally, research proposals aiming at the realization of biological supremacy that concerns topics other than the abovementioned ones, and those that span multiple items, are also invited.

In all the groups, we expect proposals that will lead to collaboration with members of the Planned Research belonging to the same or different Research Groups.

3. Research Group, Upper Limit of Annual Budget and Number of research projects scheduled to be selected

Research Group Number	Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A01	Theory of Multicellular Neurobiocomputing	2.5	5
A02	Multicellular Neurobiocomputing in Artificial Systems	5	14
A03	Multicellular Neurobiocomputing in Biological Systems		
A04	Hardware Applications of Multicellular Neurobiocomputing		

Research Outline of Research Areas

Global Antarctic Science: connecting the chain of changing huge ice sheet and global environments
http://glaces.lowtem.hokudai.ac.jp

Number of Research Area	:	24A402	Term of Project :	FY2024-2028
Head Investigator	:	AOKI Shigeru		
Research Institution	:	Hokkaido University, Institute of Low Temperature Science		

1. Details of Research Area

On-going global warming may locally destabilize the Antarctic ice sheet beyond a critical threshold, causing the global sea level rise beyond a rate previously thought. The disintegration of the Antarctic ice sheet could be the first domino to fall, leading to cascades of global tipping point elements. Conversely, the atmosphere, which has become wetter on a global scale, can increase the amount of snowfall on the Antarctic ice sheet, counteracting the mass loss. The time scales required for the changes in these components are completely different; hundreds to tens of thousands of years for the ice sheets and a few hours to a few years for the atmosphere. The complexity of the interactions among phenomena of such different spatial and temporal scales is a factor that prevents improvements in the future predictions. In this Research Area, we focus on the "short-term" from post-Industrial Revolution and "long-term" from hundreds of thousands of years ago. We elucidate the processes by which Antarctic change and its global cascades are activated in various climatic conditions. By combining innovative observations, sample analysis and numerical simulations, we aim to establish a new Research Area of "Global Antarctic Science" that comprehensively studies the interactions between the Antarctic ice sheet and the global climate system over a wide time range into the near future, thereby contributing to new developments in climate and environmental science.

2. Call for Proposals and Expectations for Publicly Offered Research, etc.

In Publicly Offered Research, we welcome proposals that will directly collaborate with the Research Groups of A01-A03. Research Area focuses on the various processes among Antarctic ice sheet and surrounding ocean/sea ice and atmosphere. This includes research on the formation and changes of Antarctic Bottom Water and research on cycles of materials such as nutrients and iron. We welcome research using sample analysis and numerical experiments to investigate the actual state and mechanism of the historical changes in the Antarctic and global environment on the long-term scale.

We also welcome proposals for the following Research Groups of B01-B03, which complement and/or expand on A01-03.
B01: In order to clarify the climate system interaction in the Antarctic region and its global impact, comparative research with the Arctic region is effective. We look forward to research that will clarify the commonality and uniqueness of the interaction process, as well as the mutual influence between the two poles.
B02: We welcome research using satellites remote sensing and new analysis algorithms. We also hope for proposals of new models such as isotope models, ecosystem models, earth system models, etc., and theoretical research from new perspectives.
B03: Environmental research in Antarctica requires innovative development and application of methods based on new ideas. We hope that the development of in-situ observational methods without constant human instructions and the creation of unprecedented paleoenvironmental indicators will lead to research breakthroughs.

We set two categories of budget: one for theoretical and/or relatively small-scale research and one that requires more costs for equipment, analysis, personnel expenses, etc. We welcome proposals from a wide range of researchers; from experienced researchers in the Antarctic-related research to young researchers who will conduct related research for the first time. For proposals that require observations in the Antarctic region, however, please bear in mind that acceptance or rejection in this Publicly Offered Research does not imply whether they can be implemented in the Japanese Antarctic Research Expedition.

3. Research Group, Upper Limit of Annual Budget and Number of research projects scheduled to be selected

Research Group Number	Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A01	Revealing key processes and multi-sphere interactions driving the present variability of Antarctic Ice Sheet	3 1.4	4 12
A02	Under-ice observations using oceanic autonomous robotic system		
A03	Revealing the variability and interaction of Antarctic Ice Sheet and global climate on long time scales		
B01	Comparative study of the northern- and southern-hemisphere polar regions and oceans		
B02	Various satellite observations, theories and numerical modeling		
B03	Development and application of innovative method and technique		