(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.

- It is possible to receive grants for up to 2 projects in Publicly Offered Research.
  In case that there are no projects of Publicly Offered Research for which grants has currently been received, it is possible to apply and receive grants for new 2 projects. However, it is not possible to apply and receive grants for 2 projects in the same research area.
  In case that grants have been received for 2 projects continuation of which will be in FY2020 in Publicly Offered Research, it is not possible to apply for another project.

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

1 Construction of the Face-Body studies in transcultural conditions

http://kao-shintai.jp/

Number of Research Area	:	1901	Term of Project :	FY2017-2021
Head Investigator	:	YAMAGUCHI K., Masami		
Research Institution	:	Chuo University, Department of psychology		

We will clarify the sub-conscious processing of facial and corporeal expressions in order to better understand the fusion among different people and different cultures. For example, by analyzing a person's gaze, of which one is normally unaware, it is possible to understand the communication and expression strategies enclosed within a single culture from the perspective of cultural diversity. Understanding facial and corporeal expressions in transcultural situations in turn leads to the acceptance of others, different cultures, and heterogeneity.

This project consists of three research groups: "Examination of the cross-cultural aspects of facial and corporeal expressions (research group: A01)," "Elucidating the mechanisms that create the facial and corporeal expressions of different cultures (research group: B01)," and "Comparative phenomenology of facial and corporeal expressions (research group: C01)." Empirical data and evidence will be collected by field research (mainly in A01) and experimental research (mainly in B01), with each aimed at cultural difference comparison and understanding of foreign cultures. Experimental studies in B01 elucidate the basic mechanism that creates cultural impact and diversity revealed in A01. Theoretical studies in C01 are utilized for establishing theoretical basis for phenomena and data obtained in A01 and B01. The three project areas are linked organically. We encourage proposals from researchers of various backgrounds, particularly young researchers, to promote interdisciplinary collaboration and exchange. We support this research collaboration and exchange by actively employing research content with novel ideas and by providing budgetary and organizational support. We also welcome proposals of engineering research aiming to offer novel technology to our project. The budgetary range for publicly offered research is presumed to be between 1 million yen (e.g., theoretical research in C01) to a maximum of 2 million yen (e.g., research using functional brain imaging in B01) per annum.

Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A01: Examination of the cross-cultural aspects of facial and corporeal expressions; Research on facial and corporeal expressions and representations, mainly comprising cultural anthropology fieldwork. This also includes collaborative research with neighboring fields.	1	4
	1.5	3
	2	1
B01: Elucidate the mechanisms that create the facial and corporeal expressions of different culture; Experimental studies in the fields of experimental and cognitive psychology, neuroscience and clinical studies. This area also includes studies tied with expressive techniques.	1	5
	1.5	5
	2	2
C01: Comparative phenomenology of facial and corporeal expressions; Research based on philosophical examinations, including cosmetology, linguistics, literary studies, sociology, ethics, aesthetics and art theory, and comparative phenomenology.	1	4

2 Creation of the study of reconciliation

http://www.prj-wakai.com/

Number of Research Area	:	1902	Term of Project :	FY2017-2021
Head Investigator	:	ASANO, Toyomi		
Research Institution	:	Waseda University, Faculty of Political Science and Economics		

This research project attempts to establish the academic basis for "Reconciliation Studies" by reexamining "conflict resolution studies," first developed in the field of "International Relations" in Western academia, focusing specifically on the historical context of East Asia. In East Asia, the "bitter legacies" of war and colonialism came to be the core of national emotions and historical memories and continue to interrupt the construction of stable regional relations, producing mistrust among nations. In view of the current situation in which these historical issues are increasing conflict between Japan and Korea in 2019, nationalism theory backed by East Asian historical contexts should be combined with conflict resolution studies.

The creation of "Reconciliation Studies" has been established in order to gather scholars from around the world and to reconcile disputes over historical issues in East Asia since 2017. We observed that many attempts to realize reconciliation were always subjugated to the theory of realism and economic liberalism favoring national interest and power. This project, in contrast, aims eventually to have an age in which it is possible for people to imagine reconciliation between nations, similar to how people imagine an anonymous community as a nation. This project will explore the social conditions in which the concept of imaginable reconciliation can be possible by forming an intellectual framework as a first step. We are also planning to establish a new academic association of 'International Reconciliation Studies' and develop it from East Asia.

We publicly call for innovative research plans from any researcher whose research interest is closely associated with our project in the following categories. Under the category of A02-A06, we invite research plans focusing on theoretical and empirical studies upon each actor which is related with national emotions. Under the category of B01-B06, we call for research plans focusing on concrete cases and specific issue which impinge upon some actors mentioned above.

Applicants should be able to collaborate in order to establish the theoretical and empirical bases of a new academic field of "Reconciliation Studies." We welcome ambitious research plans not only from history and political science, but also from other disciplines such as sociology, anthropology, psychology, legal philosophy, and so on.

Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A02 Research on Political & Diplomatic history (Comparative analysis of reparations and claims, Normalization of diplomatic relations after decolonization of Empires , etc.)	1.2	4
A03 Research on Thought & Theory (Transitional Justice theory, Reciprocal reconfiguration between domestic and international politics over history issues, etc.)		
A04 Research on Network of Historians (Historiography of joint history projects in East Asia, Emotional History, etc.)		
A05 Research on Citizen Activism (Studies upon citizens, civil associations and NPO which were in charge of history issues)		
A06 Research on Cultural Reconciliation & Memory (How memories have been formed through media, television and film)		
B01 Research on residual orphans, returnees, support and settlement of Japanese repatriates, the settlement process, etc.		
B02 Research on comfort women, nurses and gender activists		
B03 Research on military qualifications, compensation for detainees, trials, etc.		
B04 Research on war and recruitment of civilians, militaryvotes, private company responsibilities, etc.		
B05 Research on memory, memorial service, museums, etc.		
B06 Research on history education (common textbooks, comparison with European history education, etc.)		

3 Integrative Human Historical Science of "Out of Eurasia": Exploring the Mechanisms of the Development of Civilization

http://out-of-eurasia.jp

Number of Research Area	:	5101	Term of Project :	FY2019-2023
Head Investigator	:	MATSUMOTO, Naoko		
Research Institution	:	Okayama University, Graduate School of Humanities and Social Sciences		

The project aims to clarify the mechanism of the creation of civilization, by analyzing the material data from the period of its development based on the model of the mutual permeation of matter and mind as mediated by the body. The Americas, the Japanese archipelago, and Oceania, the regions of final destination for *Homo sapiens* who left Eurasia and dispersed by overcoming bottlenecks and extreme conditions, are selected as the object to investigate the processes which unfolded independently under different natural environmental and historical circumstances. Our goal is to establish the truly integrated research field that enable to propose a new view of human and culture, overcoming the dualistic mind–body and mind–matter frameworks that have formed the basis of modern science.

We invite research projects that complement our active transdisciplinary project consisting of many disciplines. In a close collaboration with the Research Groups in our project, invited research projects are expected to investigate various periods and areas in the extra-Eurasian region, either empirically or theoretically, to contribute to the establishment of methodological framework of Integrated Human Historical Science. Our ultimate purpose is to understand the nature of civilization which has brought about the modern world and provide a scientific foundation for the actions for the future. Thus innovative research projects by younger researchers are the most welcome.

We invite: 1) research projects that are related to one of our Research Groups A01-03, B01-03, and C01 with a complimentary research field or view point, 2) empirical and highly innovative research projects related to more than one Research Groups, 3) theoretical and/or methodological research concerning the construction of the Integrated Human Historical Science, and 4) researches to develop analytical method for Big Data, 3d images, or GIS.

Annual research grant is basically up to 2 million yen, but 4 million yen for transdisciplinary research that requires fieldwork or research instruments, and 5 million yen for experimental research projects.

Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A01 Creation of Artificial Landscape and Development of Spatiotemporal Cognition	5	2
A02 How art and technology connect mind, body, and society	4	2
A03 Growing complexity of social groups and warfare	2	14
B01 Sociocultural mechanisms underlying niche construction based on ethnographic research		
B02 Neurobiological mechanisms of cognitive niche construction		
B03 Genetic diversity and physical changes associated with human dispersal and the development of complex societies		
C01 Integrative studies of anthropological, archaeological, and cognitive evidence through 3D database construction and mathematical analyses and modeling		

4 Aqua planetology

http://www.aquaplanetology.jp/

Number of Research Area	:	2901	Term of Project :	FY2017-2021
Head Investigator	:	SEKINE, Yasuhito		
Research Institution	:	Tokyo Institute of Technology, Earth-Life Science Institute		

Recent advances in spacecraft explorations have revealed the present/past existence of liquid water on planetary bodies beyond Earth in the Solar system. Our research project proposes a new field of research – aqua planetology – that aims at comprehensive understanding on the roles of liquid water in the origin and evolution of planets and on habitability there. This requires research interactions between geology, geochemistry, biosphere science, astronomy, and planetary science. We try to achieve this goal both by constructing a theory of chemical reactions and hydrological cycles on planetary bodies and by collecting observational evidence through spacecraft missions, such as Hayabusa2, and geochemical analyses of extraterrestrial samples. The expected achievements of our research project include 1) understanding of hydrological cycles within planetesimals and the factors that control water volume of Earth, and 2) revealing the evolution of aqueous environments and prediction of biosphere on Mars and icy satellites.

In our research project, the subgroup A01 performs laboratory experiments on water-rock reactions and predicts planetary biospheres, the subgroup A02 performs experiments of water-ice interactions on planetary surfaces, A03 constructs numerical models of planetary geochemical cycles through including experimental data obtained by the subgroups A01 and A02, B01 constructs a X-ray microscope for molecular geochemical analyses and develops proxies to reconstruct aqueous environments from extraterrestrial samples, and B02 performs analyses of data obtained by Solar system explorations, including Hayabusa2, Mars missions, and icy satellite missions.

As publicly invited researches of Type I, we expect innovative researches in surrounding areas of aqua planetology, including hydrology, extremophile microbiology, field geology, Solar system exploration science, and Solar system astronomy. As Type I, researches that have long-term scopes in related research fields are also expected. As Type II, we expect interdisciplinary researches that utilize the research resources developed by our research project, such as Hayabusa2 data and X-ray microscope. Researches that aim to reveal co-evolution of planetary environments and life and that develop science instruments for future space explorations are also expected as Type II.

Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A01 Water-rock reactions	2 (Type I) 5 (Type II)	6 6
A02 Water-ice interactions		
A03 Modeling of cycles		
B01 Molecular geochemistry		
B02 Solar system exploration		

5 Discrete Geometric Analysis for Materials Design

https://www.math-materials.jp/

Number of Research Area	:	2902	Term of Project :	FY2017-2021
Head Investigator	:	KOTANI, Motoko		
Research Institution	:	Tohoku University, Graduate School of Science		

A new research area is proposed in collaboration between mathematics and materials science in order to understand the structure-function-process correlation principle and develop mathematics for new phase materials. We invite proposals of various mathematical methods and concepts, and also challenges in materials science to cooperate with mathematical ideas. Successful applications are not necessarily by interdisciplinary teams but are expected to be active and show exceptional potential for leadership in interdisciplinary collaborations in promoting this project.

A01 targets topological materials. Mathematical/theoretical proposals to discover a universal framework to explain robust topological phases, or experimental proposals to produce/analyze topological materials by employing mathematical models are expected.

A02 targets understanding of structures of polymer materials which prohibit multi-functions as hierarchical networks. Mathematical/ computational analysis of the structures or synthesis of soft matters including liquid crystals, gels, colloidal materials along the line are most welcome.

A03 targets nano-porous materials. Proposals of mathematical/computational approaches to understand dynamical formations of multi-continuous structures or synthesis/ control of various porous materials expected.

B01 targets developments of new methods and theories in information science and data science for material design

Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A01 (inorganic): topological materials	9	5
A02 (organic): polymer materials using network analysis		
A03 (composite): dynamical formation of nano-porous materials	3	15
B01 Information science for material design		

6 Soft Crystals: Science and Photofunctions of Flexible Response Systems with High Order

http://www.softcrystal.org

Number of Research Area	:	2903	1	Term of Project :	FY2017-2021
Head Investigator	:	KATO, Masako			
Research Institution	:	Hokkaido University, Faculty of Science			

This project aims to establish a new science concerning "Soft Crystals", which respond to macroscopic gentle stimuli (e.g. vapor exposure, rubbing, and rotation) that exhibit visually remarkable changes such as luminescence and optical properties. This project also aims to develop novel functional materials on the basis of the scientific achievements. "Soft Crystals" are regulated solids with stable and highly ordered structures. However, they are characteristic of facile structural transformations and phase transitions in response to weak but particular stimuli. One of scientifically most important challenges is to clarify the phenomena of the formation and phase-transition of "Soft Crystals". Through the scientific research, we aim to create a new area, which can provide new materials beyond the conventional hard crystals and/or soft matters.

In this research area, the following three research groups, A01–A03, will promote research cooperatively to establish a new fusion area with the concept of Soft Crystals. For all the three groups, experimental and theoretical researchers will collaborate closely with each other for effective studies. Proposals for unique research projects which are expected to promote this area greatly are very welcome. In particular, the studies based on theoretical and physical approaches could take important parts.

Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A01 Development of Soft Crystals through molecular design & synthesis	2.5	8
A02 Development of Soft Crystals with novel structures and morphology	2.5	8
A03 Development of Soft Crystals with superior physical properties & functions	2.5	8

7 Chemistry for Multimolecular Crowding Biosystems

http://www.bunshi-kyouzatsu.jp

Number of Research Area	:	2904	Term of Project :	FY2017-2021
Head Investigator	:	HAMACHI, Itaru		
Research Institution	:	Kyoto University, Graduate School of Engineering		

Live cells and tissues are multimolecular crowding biosystems consisting of many kinds of biological molecules densely condensed in the closed small spaces. However, conventional biochemical researches ignored such complicated environments where biological molecules reside, and most experiments have been conducted in a purified and dilute solution. The purpose of our research project is to establish new chemical approaches available for functional analysis and artificial regulation of biological molecules in the multimolecular crowding biosystems. Accumulating cutting-edge findings from a broad range of research fields (chemical biology, synthetic biology, biophysical chemistry, nano-bioengineering, etc.), we aim to quantitatively describe the multimolecular crowding biosystems and to devise new molecules and methods, which contribute to innovate on bioimaging, drug discovery and disease diagnosis. We envision that our researches could create a new trend for biofunctional life chemistry.

This research project consists of three teams (A01 – A03) to promote individual researches on their specific topics. Meanwhile, the project highly encourages collaborative researches between the project members. A01 team focuses on development of chemical strategies, establishment of molecular design and synthesis of artificial probes and modulators for analyzing and regulating biomolecules available in cells and tissues. A02 team focuses on quantitative analysis and description of multimolecular crowding biosystems on the basis of biophysical and computational chemistry. A03 team focuses on creation of new nanobio-devices for analyzing and diagnosing specific biological molecules (biomarkers) in cells, tissues and in vivo. This project also plans to establish Center for Integrated Biomolecular Chemistry (CIBIC) as a hub that underpins and promotes collaborative research between the project members. A variety of the instruments, chemical tools, methods and know-how for accelerating integrated research can be shared by all of the members through operating CIBIC.

We expect many applications from publicly offered research, which propose attractive projects and can complement the planned researches conducted by main project members, in order to accomplish the ultimate goal of this project. We call for the two types of research application with the different budget limit; one is pioneering and challenging research (2.5 million yen per year), and another one is comprehensive and high impact research (5 million yen per year), both of which will be expected to bring excellent results.

Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A01 Synthetic chemistry for multimolecular crowding biosystems	2.5 5	18 5
A02 Physical and computation chemistry for multimolecular crowding biosystems		
A03 Analytical and applied chemistry for multimolecular crowding biosystems		

8 Gravitational wave physics and astronomy: Genesis

http://gw-genesis.scphys.kyoto-u.ac.jp

Number of Research Area	:	2905	Term of Project :	FY2017-2021
Head Investigator	:	TANAKA, Takahiro		
Research Institution	:	Kyoto University, Graduate School of Science		

In 2016, the LIGO reported the first direct detection of gravitational waves (GWs). Since then, the Virgo joined the observation network, which has dramatically increased the GW detection events, including the epoch-making binary neutron star merger event GW170817. KAGRA, the Japanese GW detector, is about to enter the actual observational stage by the end of this year. Japan has strong points in data analysis of GWs, multi-wavelength observations of astronomical objects corresponding to the GW sources and theoretical studies. The purpose of this area is, by integrating these existing specialties, to push forward the trend of the genesis of GW physics and astronomy, and to establish a new research field from the two aspects "comprehensive analysis of GW data" and "new physics and astronomy that expand from GW detection".

In order to achieve this objective, this innovative area includes various research subjects such as testing gravity theories, cosmology, star formation, neutron star structure, origin of gamma ray burst, galaxy chemical evolution, and supernova physics. Following the detection of GWs, the relevant research areas to be included in our collaboration are rapidly expanding, and it is expected to develop even to unpredictable directions along with future new findings. In our planned research projects, we focused on the selected contents in order to clarify our scientific goals. For that reason, there are many issues being not included as research in the peripheral field. Even as for the research contents already categorized in the planned research projects, new research fields are still expanding when considering and reexamining relevant subjects more widely or deeply. Subscription research is open to such research proposals widely.

In pursuit of the explosive progress of GW research, the objective is to initiate new researches leading the world from this innovative area, and from that point of view, we would like to adopt projects that are creative and internationally competitive. Finally, we encourage such researches that suit with the keyword “establishing new physics and astronomy that expand from GW detection".

Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A01 Testing gravity theories using gravitational waves		
A02 New developments of gravity theory research in gravitational wave physics and astronomy		
A03 Theoretical study on binary black hole formation		
B01 Physics and astrophysics with gravitational waves from binary neutron star coalescences, black hole neutron star coalescences, pulsars and magnetars	4 2 1	3 6 12
B02 Gravitational wave sources probed with high energy observations		
B03 Study of nucleosynthesis in neutron star merger with optical-infrared follow-up observations of gravitational wave sources		
C01 Deciphering physics of core-collapse supernovae via gravitational-wave astronomy		
C02 Studying supernova explosions via their neutrino emissions		

9 Frontier research on chemical communications

http://www.pharm.kyoto-u.ac.jp/fr_chemcomm

Number of Research Area	:	2906	Term of Project :	FY2017-2021
Head Investigator	:	KAKEYA, Hideaki		
Research Institution	:	Kyoto University, Graduate School of Pharmaceutical Sciences		

Many natural products have served as pharmaceuticals, agrochemicals, and their leads because of the structural and biological diversity. However, essential roles of natural products as chemical communication molecules among microbes, animals, plants, et cetera have not been fully elucidated. Integrated understanding of various kinds of chemical communications could therefore accelerate functional regulation by utilizing chemical communication molecules.

This research project aims at not only developing innovative high-order analysis platforms, but also at clarifying essential roles of natural products as chemical communication molecules in the natural environment, leading to development of useful chemical tools as well as pharmaceuticals/agrochemicals leads. In addition, this research project would contribute to the advancement in medical, agricultural, and food sciences, as well as open up a new discipline, "Molecular Sociology", which would focus on the frontiers in chemical communications in a variety of biological species.

In this research area, the following three research groups interact closely with each other.

Group A01 (Chemical Communications in Biological Species): Screening and development of bioactive natural products as chemical communication molecules by a target-based phenotypic screening approach.

Group A02 (Ligand-induced Chemical Communications): Development of bioactive synthetic ligands as chemical communication molecules by theoretical design and synthesis and physicochemical approach.

Group A03 (Integrated Methods for Chemical Communication Analysis): Development and application of integrated platforms for identifying chemical communication molecules and analyzing their modes of action.

Now, attractive applications in various research fields such as chemical ecology, environmental science, pharmacology, structural biology, synthetic chemistry, artificial intelligence, and bioinformatics, as well as natural product chemistry, with synergistic, transversal, and applied perspectives, are openly recruited for these research groups. The applications by young researchers are also encouraged.

Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A01 Chemical Communications in Biological Species	2.5	8
A02 Ligand-induced Chemical Communications	2.5	8
A03 Integrated Methods for Chemical Communication Analysis	2.5	8

10 Hybrid Catalysis for Enabling Molecular Synthesis on Demand

http://hybridcatalysis.jp

Number of Research Area	:	2907	Term of Project :	FY2017-2021
Head Investigator	:	KANAI, Motomu		
Research Institution	:	The University of Tokyo, Graduate School of Pharmaceutical Sciences		

Organic synthesis has been consistently developed and refined up to the present, but several important issues remain unresolved. One such issue is the practical synthesis of high-value-added complex molecules through streamlined multicatalytic reactions starting from readily-available, abundant molecules. Nature utilizes multicatalytic (i.e., multienzymatic) systems for the biosynthesis of natural products. The most effective artificial multicatalyst system in a flask so far, however, promotes only two or three reactions at most. With this in mind, the purpose of our research project is to develop hybrid catalysis, a multicatalytic system involving catalysts with distinct individual functions. Integrating the functions of multiple catalysts, hybrid catalysis will enable molecular synthesis of high efficiency, flexibility, and adaptability on demand, starting from abundant organic molecules.

Group A01 focuses on the development of new activation methods of stable molecules using hybrid catalysis, including hydrocarbons and other carbon feedstocks. Group A02 focuses on the development of the methods to precisely control multiple reaction parameters, including regio-, functional-group, and stereoselectivity, with high flexibility and adaptability. Group A03 focuses on the development of domino catalysis rapidly increasing structural complexity, starting from simple molecules to multifunctional molecules.

Original and ground-breaking proposals for the development of hybrid catalysis, achievable especially through collaboration in the research project framework, will be considered as candidates. Innovative proposals from young researchers leading to game-changing catalyst systems, are most welcome. As examples, we would accept proposals for homogenous/heterogenous hybrid catalyst systems and proposals for analytical methods related to the elucidation of reaction mechanisms. We encourage the applicants to describe in the proposal possible collaboration research plans with the Planned Research(es) of the Hybrid Catalysis research area.

Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A01 Activation methods of stable molecules	3	20
A02 Precise controls of selectivity	2	10
A03 Super-efficient molecular synthesis		

11 Physical Properties of Quantum Liquid Crystals

http://qlc.jp

Number of Research Area	:	6101	Term of Project :	FY2019-2023
Head Investigator	:	SHIBAUCHI, Takasada		
Research Institution	:	The University of Tokyo, Graduate School of Frontier Sciences		

Recently, novel electronic states similar to conventional liquid crystals such as spin liquid crystals, electronic nematic orders, and pair density wave have been observed in several solid materials, and studied independently in each research field. In this research project, we focus on these self-organized electronic states with new scales arising from many-body quantum effects, and introduce a new concept "quantum liquid crystals" (QLCs) to unify these novel states of matter. Here we explore broad QLC materials like quantum fluid systems with broken symmetries and conventional liquid crystals exhibiting some quantum effects, in addition to the above-mentioned examples, and study both the universality and diversity of QLCs.

We call for research proposals with original ideas and new viewpoints, complementary to the planned research. A total of 12 grants will be funded. Applications will be considered in any area of research relating to quantum liquid crystals. This research may be fundamental in nature, or orientated to method development and future quantum technology, and need not be based on previous research on electronic states. Within this broad area, four major themes have been identified. Research group A01 aims to develop and synthesize materials that exhibit QLC states, and distributes them to other experimental research groups. We welcome proposals treating broad materials including organic and molecular-based materials, as well as complexes and metal-organic frameworks. In research group B01, we invite research proposals to clarify the ground states and elementary excitations of QLCs, and especially those focusing on hierarchy structures of length and time scales. Research group C01 calls for theoretical research proposals on QLC states and related emerging phenomena, with emphasis on cooperation with experimental research groups. In research group D01, we welcome research proposals aiming to control QLCs by using a variety of methods and searching for novel functionality based on a macroscopic change in physical properties.

We also call for collaborative research proposals promoting relationship between researchers in different fields, or interdisciplinary research proposals from outside of the research field of physical properties in inorganic systems. Especially, proposals from research fields of soft-matter including liquid crystals, organic materials, quantum information, applied mathematics, etc. are welcomed. For experimental proposals, we will accept 2 large-scale research proposals with annual budget up to 5 million yen.

Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A01 Development of QLC materials	Experimental: 5	2
B01 Advanced measurements of QLCs	Experimental: 3	6
C01 Theory of QLCs	Theoretical: 1.5	4
D01 Control and functionality of QLCs		

12 Mid-latitude ocean-atmosphere interaction hotspots under the changing climate

http://www.jamstec.go.jp/apl/hotspot2/

Number of Research Area	:	6102	Term of Project :	FY2019-2023
Head Investigator	:	NONAKA, Masami		
Research Institution	:	Japan Agency for Marine-Earth Science and Technology, Application Laboratory		

Replacing the conventional assumption that the mid-latitude ocean is passive to atmospheric variability, we have established a new paradigm that strong warm currents (e.g., the Kuroshio and the Gulf Stream) and associated strong ocean frontal zones play active roles in the climate system as "climate hotspots." In this project, we plan to further develop the new paradigm by bringing together latest observational and numerical modeling studies, and to apply these results to studies on the predictability of ocean/atmosphere variability and global warming, showing scientific and societal importance and validity of the paradigm. More specifically, we will investigate multiple spatio-temporal scale interactions in *climate hotspots*; how they can affect the predictability of extreme weather (such as typhoons and bomb cyclones) and ocean currents; and how *climate hotspots* play a role in the warming climate.

There are three planned-research groups based on time scales of variability: (A01) extreme weather on several-day scale, (A02) ocean/atmosphere variability on 10-day to several-year scales, and (A03) roles of mid-latitude ocean-atmosphere interactions in natural variability on a longer time-scale and/or in the changing climate. Publicly Offered Research for the present project are expected to collaborate tightly with these groups and expand/deepen the whole project by complementing them and providing new insights. Applications with the following topics are highly welcomed:

i) *In situ* observational studies to understand the processes for mid-latitude ocean-atmosphere interactions. Observational studies collaborating with our planned-research observations with additional variables and/or viewpoints are expected. Challenging observational studies using the latest automated tools are also welcomed.

ii) State-of-the-art numerical high-resolution modeling studies and/or unique experiments complementing the numerical modeling and data analyses by the planned-research groups. Studies analyzing the numerical experiments by the planned-research groups from completely new viewpoints are also welcomed.

iii) Data analyses investigating mid-latitude ocean-atmosphere interaction processes including their changes under global warming. Use of data products such as CMIP5/6 outputs archived by the planned-research group, state-of-the-art satellite observations, high-resolution atmospheric objective analysis/reanalysis, and ocean data assimilation are expected.

Upper limits of the annual budget for observational and other studies are 9.7 and 3 million yen, respectively.

Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A01 Extreme events and mid-latitude ocean on weather forecast scale	9.7 3	2 6
A02 Ocean and atmosphere variability on seasonal prediction scale		
A03 Ocean and atmosphere variability relating to future mid-latitude climate projection		

13 New Materials Science on Nanoscale Structures and Functions of Crystal Defect Cores

http://www.core.mp.pse.nagoya-u.ac.jp

Number of Research Area	:	6103	Term of Project :	FY2019-2023
Head Investigator	:	MATSUNAGA, Katsuyuki		
Research Institution	:	Nagoya University, Graduate School of Engineering		

In recent advanced materials, crystal defects such as point defects, grain boundaries, interfaces and dislocations serve as physical origins of development of distinct materials properties. For future materials design, therefore, it is important to reveal structure-property relationships of crystal defects at the nanometer scale. Recent progresses on nanoscale characterization and computational science are remarkable, and make it possible to acquire nanoscale information on crystals defects in materials quantitatively. In most cases, however, previous information on crystal defects is limited to data on their static atomic structures. In order to realize materials design and development from the nanometer scale, it is essential to obtain systematic understanding of not only static atomic structures of crystal defects but also their localized quantum structures in response to external electromagnetic and temperature fields. In this project, the localized electronic and atomic structures of crystal defects are referred to as "crystal defect cores" that can bring about distinct or peculiar materials properties, and researchers specializing in theoretical calculations, nanoscale characterization and advanced materials processing conduct collaborative studies on crystal defects in advanced materials. We aim at establishing novel scientific principles in materials science based on the concept of "crystal defect cores", and at further developing novel materials functions and exploratory materials by designing and controlling crystal defects.

The research group A01 focuses on theoretical researches by first-principles based calculations and information-science based techniques, and the research group A02 covers experimental nanoscale characterization of electronic and atomic structures at grain boundaries, interfaces and dislocations. Major topics in the research group A03 involve development of novel materials functions and exploratory materials by using diverse advanced materials processing techniques.

In particular, we expect proposals that plan to develop computational analysis methods, experimental characterization techniques and advanced materials that are not covered in the main research groups of the project. Proposals that conduct intimate collaborative studies with other researchers in the project and can stimulate research activity of the whole project are desirable. Researchers whose proposals are accepted are allowed to use common specimens and facilities available within the project. Challenging proposals from younger researchers are highly welcome.

Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A01 Modeling and design of crystal defect cores	3	3
A02 Nanoscale characterization of crystal defect cores	3	3
A03 Materials development based on crystal defect cores	3	6

14 Aquatic Functional Materials: Creation of New Materials Science for Environment-Friendly and Active Functions

http:// www.aquatic-functional-materials.org/

Number of Research Area	:	6104	Term of Project :	FY2019-2023
Head Investigator	:	KATO, Takashi		
Research Institution	:	The University of Tokyo, Graduate School of Engineering		

In this research project, we focus on "Aquatic Functional Materials" which is defined as materials that exhibit functions while they harmonize and interact with environment in the existence of "water" through fusion of "materials science" and "basic science of water". We create and establish materials science on "Aquatic Functional Materials" based on fundamental science of structure-function relationship between water and materials from a wide range of standpoint of views including organic chemistry, polymer chemistry, physics, measurements and computational science, and engineering. Interactions between "water" and "materials" in the level of molecules and molecular nano-assemblies are understood for the creative development of aquatic functional materials with electronic/ionic, bio/environmental, and mechano-functions. These approaches lead to create scientific research on innovative areas in the field of advanced materials science.

Research Group A01: Studies on design of molecular assemblies, materials, and functional molecules to develop aquatic functional materials. Research Group A02: Studies on structures and dynamics of materials and water using advanced measurements and simulation. Research Group A03: Studies on exploration of electronic/ionic, bio/environmental, and mechano-functions of aquatic functional materials.

The publicly offered research will mainly focus on research proposals that fit the concept and purpose of this project to establish science of aquatic functional materials for development and contribution of Japanese materials science.

For the publicly offered research, we strongly encourage to propose creative, interdisciplinary, and challenging research plans by sharing the scope of this research project. We welcome research proposals related to creation of science of "Aquatic Functional Materials" using synthesis, analysis, characterization, and theory for molecular and structure design, and exploration of functions. Scientific backgrounds are chemistry, physics, biology, engineering, syntheses of molecules and materials, device fabrication, fundamental and applied materials science of theory, calculation, and experiments and basic science of water. Active applications of research proposals from young and/or female scientists are welcomed.

Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A01 Development of Molecules and Materials	2.5	27
A02 Advanced Measurements and Simulation		
A03 Exploration of Functions		

15 Unraveling the History of the Universe and Matter Evolution with Underground Physics

http://www.lowbg.org/ugap/

Number of Research Area	:	6105	Term of Project :	FY2019-2023
Head Investigator	:	INOUE, Kunio		
Research Institution	:	Tohoku University, Research Center for Neutrino Science		

This project pursues search for Neutrinoless double beta decay, direct search for dark matter, observation of supernova relic neutrinos and observation of geo-neutrinos with the world leading sensitivities in underground laboratories and develops "underground astroparticle physics" unraveling fundamental problems such as "How is matter created?", "How are stars/galaxies formed?", "How are elements produced?" and "How are they brought to the earth?". We advance ultra-low radioactivity techniques as a common technical base and involve novel low-temperature sensor technologies. We also aim at seamless integration of particle cosmology and cosmic chemical evolution as a theoretical framework spanning the history of the universe. Technical and scientific application/spread to the adjacent fields is also considered. For those purposes, we intensively propel the planned researches listed below, and invite two years research proposals those strength or supplement them.

We consider the following 5 types of proposals; 1. Research and development that uses or advances ultra-low radioactivity environment and its technology, 2. Emergent research developing diverse ultra-low radioactivity techniques and low-temperature sensor technologies, 3. Experimental and theoretical research that improves precision of relevant physical parameters or model calculations, 4. Research and development aiming at connection and application to diverse fields, 5. Research for theoretical development or of boundaries between fields.

Number of projects scheduled to be selected is 6 for experimental research or theoretical research requiring huge computation capped at 2.5 million yen per year, and 5 for theoretical research or small-scale experimental research capped at one million yen per year.

Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A01: Experimental research on Majorana nature of neutrinos in the inverted hierarchy region	Experimental research or theoretical research requiring huge computation 2.5	6
A02: Experimental research on Majorana nature of neutrinos and development of next generation high sensitivity s techniques using 48Ca		
B01: Direct search for dark matter with the highly sensitive large detector		
B02: Direct search for dark matter with directional sensitivity		
C01: History of star formation in the universe with high sensitivity observation of supernova relic neutrinos		
D01: Application of ultra-low radioactivity techniques to the cutting-edge astroparticle researches	Theoretical research or small-scale experimental research 1	5
D02: Increasing sensitivities of astroparticle researches with ultra-low temperature technologies		
E01: Theoretical research on new particle physics models and the evolution of the early universe unravelling the origin of matter		
E02: Theoretical research on supernova neutrinos in connection with nuclear physics and cosmic chemical evolution		

16 Hypermaterials: Innovation of materials science in hyper space

http://www.rs.tus.ac.jp/hypermaterials/html

Number of Research Area	:	6106	Term of Project :	FY2019-2023
Head Investigator	:	TAMURA, Ryuji		
Research Institution	:	Tokyo University of Science, Department of Materials Science and Technology		

"Hypermaterials" refer to a group of substances such as quasicrystals and approximant crystals, which are uniformly described in a high-dimensional space including the "complementary space". For example, a three-dimensional quasicrystal is a three-dimensional cross-sectional structure of a six-dimensional periodic crystal, and another three-dimensional space called "complementary space" is required to describe the structure. In this research project, we will establish and utilize data science in the complementary space and collaborate to synthesize new hypermaterials such as semiconducting, ceramic, polymer quasicrystals, and magnetic, quantum critical, and superconducting quasicrystals. In addition, we will pursue various physical properties closely related to high dimensions and symmetry that is impossible with conventional crystals, such as abnormal high temperature specific heat and abnormal heat conduction. Furthermore, by describing the atomic behavior, magnetic, electronic, phonon states, etc., of hypermaterials in the complementary space, which are complex in real space, we will search for hidden orders behind the complexity in a high-dimensional space, and aim to create new materials science.

We expect complementary researches that are not covered by the planned research groups. Applicants do not need to have quasicrystal research experience in the past, and once selected, they will conduct research in collaboration with the planned research groups. Samples can also be provided. Research group A01 will challenge to synthesize not only metal-based but also semiconductor-based, oxide-based, and polymer-based quasicrystals. In particular, proposals from ceramics and polymer specialists are highly welcomed. Research group A02 invites proposals on structural studies related to high-dimensional crystallography and evaluative analysis of high-dimensional crystals. Research group A03 welcomes new ideas on crystallography, first-principles calculations, structure / property prediction by data science, and high-dimensional band calculation methods. Research group A04 invites research proposals closely related to high dimensions and symmetry : investigations of new physical properties, developments and proposals of new experimental methods, and related theoretical researches, including mathematics. In addition, applied and practical researches that take advantage of the properties of hypermaterials are also invited. All research groups welcome challenging proposals especially from female and young researchers.

Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A01 Synthesis of Hypermaterials	Experimental research: 4	8
A02 Structure of Hypermaterials		
A03 Hypermaterials Informatics and the Search for Hidden Orders	Experimental research or Theoretical research: 2	7
A04 Physics of Hypermaterials and the Search for Hidden Orders		

17 Science on Interfacial Ion Dynamics for Solid State Ionics Devices

https://www.interface-ionics.jp/

Number of Research Area	:	6107	Term of Project :	FY2019-2023
Head Investigator	:	IRIYAMA, Yasutoshi		
Research Institution	:	Nagoya University, Graduate School of Engineering		

This research project aims to establish fundamental concept and principle to control ion transport and/or ion accumulation around the Interface of Solid State Ionics materials (ISSI), that is, "Interface IONICS". We aim to apply "Interface IONICS" to develop advanced solid state ionics devices such as all-solid-state batteries, all-solid-state capacitors, electronic/ion devices, etc.

This project consists of four programed research groups, that is, "A01: Model interface fabrications and researches on basic properties of the ISSI", "A02: Advanced measurements of the ISSI", "A03: Theory and data science of the ISSI", and "A04: Novel function developments of the ISSI. In the Gp-A01, advanced technologies on single crystal and thin film fabrications are applied to prepare well-designed and simple model interface and their fundamental ion transport and/or accumulation properties are investigated using electrochemical methods. In the Gp-A02, modulation and distribution of potential, ion concentration, chemical potential, electronic state, structure, phase, etc. around the ISSI are evaluated using advanced measurement techniques. In the Gp-A03, both the distribution and dynamics mechanism of ions and electrons around the ISSI are investigated using theoretical approach that combines multi-scale calculation and informatics analysis (machine learning and image / spectral analysis). In the Gp-A04, novel functional materials that enable fast ion transport and/or dense ion accumulation around the ISSI are investigated especially focusing on crystalline / amorphous interface.

The open research projects cover basic and applied researches on novel solid state ionics devices using the ISSI, novel measurements and calculation methods for the ISSI, precise structural regulation methods of the ISSI, and material researches focusing on the ISSI using nanoparticles. Proposals that can collaborate with planned researches and creative and challenging proposals by young researchers are welcome. For details of the planned researches, please see the project web site.

Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A01 Model Interface Developments	Experimental : 3 Theory & Data Science : 2	16
A02 Advanced Analysis		
A03 Theory and Data Science		
A04 Novel Function		

18 Transomic Analysis of Metabolic Adaptation

http://transomics.umin.jp/

Number of Research Area	:	3901	Term of Project :	FY2017-2021
Head Investigator	:	KURODA, Shinya		
Research Institution	:	The University of Tokyo, Graduate School of Science		

Living organisms dynamically adapt their metabolism in response to change in surrounding environment and maintain biological homeostasis. The metabolic adaptation is controlled by interplay between metabolome layer and other omic layers including genome, epigenome, transcriptome, and proteome. Interaction between multi-omic layers is here denoted as " trans-omic" network. In this research area, we aim to elucidate the mechanism of metabolic adaptation using advanced technologies for multi-omics measurements and trans-omic approaches with integration of multi-omic layers using mathematical modeling. In this area, we set up two research groups: elucidation of the mechanism of metabolic adaptation (A01), and development of trans-omic analyses (A02).

(A01) Elucidation of the mechanism of metabolic adaptation. This involves biology-orientated study. We seek studies on metabolic adaptation for various species including animals, plants, and microorganisms. We prioritize studies to elucidate biological phenomena which adapt to environmental changes by controlling metabolism from the viewpoint of trans-omics.
(A02) Technology development of trans-omic analyses. This involves technology-orientated study. Trans-omics is an integrative discipline which requires conceptual ideas, knowledge, technologies and experiences derived from a wide field of experiments and theories. In A02, we seek studies for development of omics measurement technologies for high speed, high sensitivity, quantification and multiplexing. We also consider studies for development of analytical technologies such as connecting multi-omic layers based on databases and interpreting multi-omic networks based on statistical / information science and mathematical modeling.

Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A01 Elucidation of the mechanism of metabolic adaptation	Experimental field : 5 Theoretical field : 2	8
A02 Technology development of trans-omic analyses		7

19 Evolutionary theory for constrained and directional diversities

http://constrained-evo.org/

Number of Research Area	:	3902	Term of Project :	FY2017-2021
Head Investigator	:	KURATANI, Shigeru		
Research Institution	:	RIKEN		

By detecting the correlation between the fluctuations observed through short time range and those observed through longer evolutionary time scale, this area tries to identify mechanical backgrounds and factors responsible for the bias and directionality found in phenotypic changes. It is also within the scope of this area to test the validity of Fluctuation-Response Theory, already put forth to explain the unevenness found in phenotypic evolution. Eventually, it tries to construct the framework of Biased Evolution Theory, which is expected to explain more extensively the phenotypic evolution, not only of unicellular organisms, but also of multicellular animals and plants.

Along the above noted outline, 13 research projects will be selected. Those proposals that deal with phenotypic variations, genomic changes, experimental evolutionary studies, theoretical studies, population genetics, developmental biology in evolutionary contexts will be considered. Epigenetic studies will also be within the scope.

Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A07 Constraints and Directionalities in Evolution	5	13

20 Principles of pluripotent stem cells underlying plant vitality

http://www.plant-stem-cells.jp/en/

Number of Research Area	:	3903	Term of Project :	FY2017-2021
Head Investigator	:	UMEDA, Masaaki		
Research Institution	:	Nara Institute of Science and Technology, Graduate School of Science and Technology		

Pluripotency of animal stem cells decreases shortly after fertilization, but some plant stem cells do not lose their pluripotency. These stem cells proliferate in the plant body and aid in continuous and dynamic organ growth. Plants also have the ability to induce somatic cells to become pluripotent stem cells through cell reprogramming. This unparalleled ability to increase and maintain stem cells facilitates plants to thrive in changing environments. However, there have been limited studies on stem cell characteristics of plants. Hence, this project focuses on clarifying the mechanisms underlying plant stem cell proliferation and maintenance *in vivo,* and determining the unique characteristics of plants that can freely control the pluripotency of their stem cells. Advances in collaborative research in this project will lead to an understanding of the basic principles of plant systems that facilitate the maintenance of long-lasting pluripotent stem cells.

We focused on two research themes. Research theme A01 is stem cell "quantity", which includes stem cell proliferation and the formation of new stem cells. Research theme A02, stem cell "quality", includes the maintenance of stem cells *in vivo*. Research proposals related to the behavior of pluripotent stem cells and genome homeostasis in other organisms that are related to an understanding of plant stem cells are also included. We are seeking public research proposals that will increase our understanding of stem cell regulation from different perspectives. Proposals of particular interest are those that seek to elucidate the control of stem cell division/differentiation in tissues, investigate the mechanisms underlying the induction/loss of pluripotency, conduct comparative analyses of long-lasting stem cells and transient stem cells, or explore regulatory mechanisms of stem cell niches through hormones and bioactive substances. Additionally, we welcome proposals that involve a chromatin and genome-level point of view, especially those aiming to elucidate the correlation between pluripotency and chromatin dynamics, or understand genome maintenance in stem cells. Creative research proposals by young scientists in which new research technologies are implemented for further collaborative research in this project are also welcome.

Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A01 Stem cell proliferation	4.5	13
A02 Stem cell maintenance		

21 Toward an integrative understanding of functional zones in organelles

http://www.organellezone.org

Number of Research Area	:	3904	Term of Project :	FY2017-2021
Head Investigator	:	SHIMIZU, Shigeomi		
Research Institution	:	Tokyo Medical and Dental University, Medical Research Institute		

Organelles are specialized structures in cells, which play specific roles to regulate various cellular events. The recent rapid development of imaging techniques have clarified the details of organelle dynamics, demonstrating that (1) various functional regions are dynamically formed within organelles, (2) organelle functions are made possible by the comprehensible actions of these functional regions. We named these local functional organelle regions as "zones".

We will study three organelle zones, namely, the "response zone", "communication zone", and "sorting zone". The "response zone" is a specific functional region that appears in organelles in response to various stressors. The "communication zone" is a contact region that enables the exchange of various molecules between different organelles. The "sorting zone" is a region within the endoplasmic reticulum (ER) and Golgi apparatus, in which macromolecules are specifically modified and sorted to their appropiate destinations. By analyzing these organelle zones, we aim to create a paradigm shift from organelle biology to organelle zone biology.

In order to achieve our aims, we invite researchers to submit proposals that elucidate the molecular mechanisms of zone formation and investigate their biological roles. The A01 unit targets the "response zone" and "communication zone". The "communication zone" includes a organellar contact region, such as the mitochondria-associated ER membranes (MAM). We welcome research proposals on organelle zones related to nucleus. The A02 unit targets "sorting zone". We call for research proposals elucidating the function of the ER and Golgi apparatus by clarifying the nature of "sorting zone", such as the "sugar chain-modifying sorting zone". We are also inviting original applications that target organelle zone from a variety of angles; e.g. mathematical and theoretical biology, disease-oriented organelle zone, and innovative analyzing techniques.

Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A01 Elucidation of response zone and communication zone	3.8	7
A02 Elucidation of sorting zone	3.8	5

22 Spectrum of the Sex: a continuity of phenotypes between female and male

http://park.itc.u-tokyo.ac.jp/sexspectrum/

Number of Research Area	:	3905	Term of Project :	FY2017-2021
Head Investigator	:	TACHIBANA, Makoto		
Research Institution	:	Osaka University, Graduate School of Frontier Biosciences		

We frequently found the sex phenotypes that locate between typical male and female in gene modified animals, human patients of disordered sex development, and various wild animals. We thus propose a novel concept of sex; continuous distribution between typical male and female (sex spectrum). In this regard, individual sex should be represented as a particular position in the spectrum and this position can be shifted to either direction. We aimed to reveal molecular mechanisms controlling these "positioning" and "shifting" through quantitative analyses using several parameters (e.g. expression levels of the sex chromosome genes, epigenome structure, amounts of the secreted sex steroids, activities of the sex steroid receptors, and metabolic activities). It is conceivable that the "positioning/shifting" is controlled by genetic and endocrine factors, and is influenced by environmental factors. We appreciate research projects that can address molecular mechanisms within two years. There is no limitation of species. We also appreciate research proposals as follows:

1. Studies for various sex-related phenomena other than sex development and sex reversal
2. Studies of the sex spectrum of cells/organs other than gonads
3. Studies using a unique approach (e.g. using cell lines or stem cells)
4. Study having a synergistic effect in cooperation with the planning research

Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A01 Sex spectrum and genetic factors	5	12
A02 Sex spectrum and endocrine factors		
A03 Sex spectrum and environmental factors		

23 Multimode autophagy: Diverse pathways and selectivity

http://proteolysis.jp/multimode_autophagy/

Number of Research Area	:	7101	Term of Project :	FY2019-2023
Head Investigator	:	KOMATSU, Masaaki		
Research Institution	:	Juntendo University, Graduate School of Medicine		

To date, autophagy research has focused on “macroautophagy” accompanied by autophagosome formation. However, there are actually a number of autophagy pathways including “microautophagy” that surrounds cytoplasmic components by invaginating or extending vacuolar or lysosomal membranes, “lysosomal membrane transport autophagy” in which the substrates directly pass through the lysosomal membrane and “endocytosis-mediated cellular membrane degradation”. Furthermore, although autophagy has been generally considered to be a non-selective degradation pathway, all autophagy pathways have selectivity. It has become clear that soluble proteins, liquid-liquid phase separated granules, aggregates, nucleic acids, and organelles such as mitochondria and the endoplasmic reticulum are selectively recognized, sequestered and degraded. In this research project, various pathways of autophagy and selective degradation via these pathways are integrated and defined as "multimode autophagy", and we will clarify their molecular mechanisms and physiological functions. Further, we aim for an understanding of the comprehensive self-degradation by elucidation of the linkage of, time series of, contribution of and functional evolution of each autophagy pathway. In addition, we will establish a system that can efficiently promote autophagy research by interdisciplinary fusion, training of young researchers, and international activities.

In the public offering researches, we share the research objective of an overall understanding of multimode autophagy and expect researches that will lead to an expansion of the field through joint research within the field, not limited to individual researches; specifically, researches on novel types of autophagy, challenges related to the degradation of new substrates, not limited to proteins and organelles, special techniques and research methods (including experimental methods as well as computational methods such as mathematical biology), the elucidation of membrane dynamics, research on autophagy in various biological species and development of quantitative systems for each mode of autophagy. In particular, autophagy researches other than macroautophagy, researches pursuing relationships between various autophagy pathways, and challenging proposals from the young generations are welcomed.

Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A01 Multimode autophagy	4 2.5	10 18

24 Program of totipotency: From decoding to designing

https://totipotency.biken.osaka-u.ac.jp

Number of Research Area	:	7102	Term of Project :	FY2019-2023
Head Investigator	:	OGURA, Atsuo		
Research Institution	:	RIKEN, BioResource Research Center		

Totipotency is the most undifferentiated genomic status typically found in the genome of fertilized oocytes. Totipotency is also defined as the ability of a single cell to contribute to all the cell types and tissues that emerge during development. These include the placenta in mammals. Our research area aims to identify totipotency-related factors at the multiscale levels and to regulate and reconstruct totipotency. Our ultimate goal is to establish an international research core of totipotency by combining cutting-edge analytical technologies and unique developmental engineering techniques.

To this end, our research area consists of two research groups. The first research group A01 will undertake basic researches related to totipotency; i.e., identification of the genomic sequences, epigenome, maternal factors, nuclear structure, gene expression, embryonic factors, and their interactions at the multiscale levels that ensure totipotency of fertilized/nuclear transferred oocytes. Their developmental stage-dependent changes will also be analyzed. The second research group A02 will seek for the techniques for regulation and construction of totipotency. These may include regulation of genomic reprogramming and derivation of totipotent cells.

The publicly offered researches should belong to either of the research groups, A01 or A02. While all the publicly offered researches will pursue the common goal towards understanding the mechanisms of totipotency and regulation of totipotency, their research subjects can be diverse, not being limited to fertilized oocytes. Therefore, we welcome researches on totipotency-related epigenome of germ cells, loss of totipotency in early embryos, early placentation in mammals, and transgenerational effects. As most planned researches focus on research using mammals, the publicly offered researches will be expected to cover many kinds of organisms other than mammals. Researches that synergistically promote specific planned researches to outstanding development will also be considered. In addition, proposals of technology development for the analysis of totipotency and interdisciplinary research such as biophysics will be welcomed.

Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A01 Decoding of the totipotency program	4	13
A02 Regulation and construction of totipotency		

25 Mechanisms underlying replication of non-genomic codes that mediate plasticity and robustness for cellular inheritance

http://www.non-genome.com/

Number of Research Area	:	7103	Term of Project :	FY2019-2023
Head Investigator	:	NAKANISHI, Makoto		
Research Institution	:	University of Tokyo, Institute of Medical Science		

Multicellular organisms consist of cells with diverse phenotypes even though the genomic information is essentially the same. The diversity of these cells is defined by non-genomic codes. Non-genomic information is coded by multi-layered mechanisms, containing DNA and histone modifications, non-coding RNA, higher-order structures of chromatin, and transcription factor networks as well as the interconnections of these layers. In this research project, we focus on the elucidation of the mechanisms underlying replication of non-genomic codes, including DNA methylation and histone modifications during mitotic and meiotic cell cycle. We are also interested in the interconnections of multi-layered non-genomic mechanisms and biological processes regulated by these mechanisms such as cellular differentiation.

Group A01 aims to understand the replication mechanisms of non-genomic codes, such as DNA methylation, histone modifications, non-coding RNA, high ordered chromatin structures, and transcriptional networks. Proposals to develop imaging technology, single cell and single-molecule analyses for the detection of non-genomic codes, and those to analyze the structural basis of the replication machinery are also welcomed. In Group A02, we aim to uncover the molecular basis of how replication mechanisms of non-genomic codes regulate the plasticity and robustness of differentiated cells in multicellular organisms regardless of animals and plants. These mechanisms should include stem cell renewal, maintenance of stemness, and cellular differentiation during symmetric and asymmetric divisions. By the use of mathematical and simulation analyses, the development of the methods to be able to consolidate big data from multiple layers into a single data storage is also involved in this subject. We welcome original and challenging proposals from young and/or female researchers.

Research Group		Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A01	Basic molecular mechanisms underlying replication of non-genomic codes	4	7
A02	Regulatory mechanisms of cellular function by replication of non-genomic codes	4	8

26 Intrinsic periodicity of cellular systems and its modulation as the driving force behind plant development

http://plant-periodicity.org

Number of Research Area	:	7104	Term of Project :	FY2019-2023
Head Investigator	:	NAKAJIMA, Keiji		
Research Institution	:	Nara Institute of Science and Technology, Graduate School of Science and Technology		

In this area, we aim to elucidate mechanisms and significance of producing periodic morphologies in plants that show both robustness and plasticity, through intimate collaboration among plant biologists, information scientists, and theoretical biologists.

Plants exhibit periodic morphologies in multiple scales from organelles to organs. Modulation of such periodicity enables differentiation of species-specific morphologies and environmental adaptation. Thus, in order to understand plant growth and development, it is essential to solve the question of how plants produce periodic morphologies. Along this line, special interests are directed to generators of intrinsic oscillations, mechanisms of modulating periodicity and controlling plant growth and morphogenesis at multiple levels from organelles to individuals. The area is divided into three groups; those elucidating the mechanisms of organ morphogenesis (A01), the mechanisms of cell fate and cell structure determination (A02), both by using imaging and molecular genetic techniques, and those developing new methods and technologies based on theoretical biology and information science (A03).

As for Publicly Offered Research Groups, not only proposals from plant developmental biologists and theoretical biologists, but also those from information scientists aiming to assist biological discoveries are welcome. As for proposals from biologists, those complementing subjects of the Planned Research Groups are expected. Examples include those working on non-model species, and those working with modulation of periodic morphologies in response to environmental factors. Proposals working on generic periodicity alone, such as circadian clocks and cell cycles, and those working on extremely long periodicity such as fluctuation in an evolutionary time scale, are to be excluded. Expected proposals from information scientists include, those developing new methodologies to bring about innovations to biological researches using computer vision, machine learning, augmented reality, and human augmentation.

How the proposal is expected to contribute to approaching to the goal of the area; constructing the principles in plant development based on periodicity and its modulation, or how the proposal is expected to revolutionize the methods in biological sciences, should be explicitly described in each application.

Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A01 Principles in organ morphogenesis	4	18
A02 Principles in cell fate and cell structure determination		
A03 New methods in theoretical biology and information science		

27 Preventive medicine through inflammation cellular sociology

http://inflammationcellularsociology.org

Number of Research Area	:	4901	Term of Project :	FY2017-2021
Head Investigator	:	MATSUSHIMA, Kouji		
Research Institution	:	Tokyo University of Science, Research Institute of Biomedical Sciences		

A paradigm shift from reactive to preventive health care is urgently required. In this project, by characterizing the individual cells and tissue microenvironment of inflamed tissues that together make up a "cellular society of inflammation", we will investigate the origin, pre-disease condition, progression and irreversible changes of inflammatory disease. For this purpose, we will establish the following three research groups to facilitate preventive medicine through the cellular sociology of inflammation. Group A01 will establish the cellular society of inflammation for chronic inflammatory disease with different pathogeneses and affecting different organs through basic and clinical research. Group A02 will investigate the regulation of internal and external environmental responses (i.e., stress responses, metabolism and cellular and tissue senescence) that promote initiation, progression and irreversible changes of inflammatory disease, and will establish molecular targets for preventive therapies. Group A03 will integrate this information to establish models and databases for the cellular society of inflammation. For this recruitment, we expect research proposals to have synergy with planned research by sharing experimental systems and computational analysis. We also expect proposals dealing with the modeling and simulation of the cellular society of inflammation and proposals from young researchers.

Proposals recruited under Group A01 will help to establish or generalize the concept of cellular society of inflammation through clinical and basic research related to various chronic inflammatory diseases. These proposals are also expected to include original approaches relating to single-cell transcriptome technology and data analysis. Proposals recruited under Group A02 will include basic research on stress responses, will use genetically modified animals and pharmacological inhibitors to identify and validate key signaling factors, or will use model validation and drug screening to reconstruct the cellular society of inflammation in vitro. Proposals recruited under Group A03 will develop methods that integrate spatial data from tissue imaging and quantitative gene expression data, or will generate innovative and creative simulation models.

Coordinators in planned research will support multi-omics analysis and data analysis in this research area.

Research Group		Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A01	Establishment of a cellular society of inflammation for chronic inflammatory disease	9 4	2 8
A02	Regulation of the cellular society of inflammation by environmental factors and establishment of molecular targets for preventive therapies		
A03	Establishment of socio-cellular informatics		

28 Giant reservoirs of heat/water/material : Global environmental changes driven by the Southern Ocean and the Antarctic Ice Sheet

http://grantarctic.jp

Number of Research Area	:	4902	Term of Project :	FY2017-2021
Head Investigator	:	KAWAMURA, Kenji		
Research Institution	:	National Institute of Polar Research, Division for Research and Education		

This project considers the Southern Ocean and Antarctic ice sheet as a unified system, and aims to establish "Antarctic Environmental System Science" by deep understandings of individual processes, various interactions, and global changes driven by the Antarctic. Towards these goals, field observations, analyses of various samples, numerical modeling, and collaborations of data and modeling are conducted to investigate the state and interaction between different environmental components such as ocean, ice sheet, crust, ecosystem, greenhouse gases, and their changes in the past and future. We invite research proposals in four pre-planned themes (A01 to A04) and four cross-cutting themes (B01 to B04).

A01: studies on the Southern Ocean

A02: studies on the Antarctic ice sheet and solid earth

A03: developments of unmanned probes and analyses of their data

A04: numerical modeling on various spatial and temporal scales.

See our website for details of A01 – A04.

B01: atmospheric physics and modeling (e.g., cloud physics, radiation process, boundary layer, relationship between global-scale and Antarctic circulations, regional climate model, analysis of new-generation high-resolution global model)

B02: various satellite observations (e.g., remote sensing of ice sheet, sea ice, ocean and ecosystem)

B03: research using new observational and analytical methods (e.g., development of unmanned underwater vehicles and airplanes, observations with unmanned probes, bio-logging, observations with new technology, development and improvement of paleoenvironmental proxies)

B04: data analyses and modeling from different viewpoints than the pre-planned research (e.g., analyses of new data and model results generated in our research with advanced statistical or informatics methods, social and economic impacts of sea level rise induced by melting Antarctic ice sheet)

In order to accommodate applications that require relatively high costs for observational or analytical equipment, sample analyses, employment (postdoc, technician), etc., two types of upper limits are offered.

Researchers from wide range of scientific disciplines and career stages are welcome, including those who have not been engaged in Antarctic research, and young researchers.

Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A01 Reservoir of heat and materials: Southern Ocean and its variations	7.5 2.5	4 12
A02 Reservoir of water and heat: Antarctic ice sheet and its variations		
A03 Challenges for unexplored frontiers		
A04 Integrative modeling of the Antarctic ice sheet, ocean, and climate		
B01 Atmospheric physics and modeling (cross-cutting theme)		
B02 Various satellite observations (cross-cutting theme)		
B03 Research using new observation and analytical methods (cross-cutting theme)		
B04 Analyses and modeling of acquired data (cross-cutting theme)		

29 Studies of Language Evolution for Co-creative Human Communication

http://evolinguistics.net

Number of Research Area	:	4903	Term of Project :	FY2017-2021
Head Investigator	:	OKANOYA, Kazuo		
Research Institution	:	The University of Tokyo, Graduate School of Arts and Sciences		

The purpose of this research project is twofold: Firstly, we aim to construct a scenario of language evolution which is consistent with linguistics, biology, and human evolutionary and developmental studies, the adequacy of which is to be validated by constructive methods including mathematical models. Secondly, on the basis of the scenario we make proposals for our future communication and continued existence of the human species. Through these endeavors, our ultimate goal is to form a new interdisciplinary area of human science – *Evolinguistics*. Language is an epoch-making technology which allowed humans to integrate individual knowledge into civilizations. Currently humans are in the process of creating new forms of communication based on language and information technology. By understanding the origins and evolution of language, we believe that we can design better methods of communication for the future and contribute to the sustainable development of the human species.

We invite public researches which will further develop, complement or bridge our planned researches described below (see our website for details). Empirical studies include experiments, surveys and fieldwork. Research group A01 investigates the origins and evolution of human language by integrating the advantages of generative grammar and cognitive linguistics, to be strengthened by other frameworks including phonology and historical linguistics. B01 studies the evolution of subfunctions for language by conducting comparative studies on a variety of species at the levels of genomes, neural circuits, behaviors, and ecology. B02 uses the methods of anthropology, archaeology, primate ecology, comparative cognitive science, and evolutionary modeling to infer the timing and the selective mechanisms of the emergence of those subfunctions underlying language. B03 studies the emergence of hierarchical structure and intention sharing in child language development to infer the phylogeny of language in light of its ontogeny. C01 explores the biological and cultural evolution of co-creative communication by using constructive methods such as mathematical models, simulations, language evolution experiments, dialogue experiments, and interactive robot experiments. As a whole, we especially welcome proposals which will contribute to the diversification of this project.

Research Group	Upper Limit of Annual Budget (Million yen)		Number of research projects scheduled to be selected
A01 Theoretical Frameworks for Studying the Origins and Evolution of Language	Theoretical and empirical studies	2	6
B01 Biological Realization of Prelinguistic Functions	Large-scale empirical studies Theoretical and empirical studies	4 2	2 2
B02 Anthropological Study on the Emergence of Language	Large-scale empirical studies Theoretical and empirical studies	4 2	2 2
B03 Cognitive Scientific Study on the Development of Language	Large-scale empirical studies Theoretical and empirical studies	4 2	2 2
C01 Constructive Understanding of the Origins and Evolution of Language	Large-scale empirical studies Theoretical and empirical studies	4 2	2 2

30 Integrated analysis and regulation of cellular diversity

http://cDiversity.umin.jp/

Number of Research Area	:	4904	Term of Project :	FY2017-2021
Head Investigator	:	FUJITA, Naoya		
Research Institution	:	Japanese Foundation for Cancer Research, The Cancer Chemotherapy Center		

A human body is estimated to be composed of 3.7 x 10^{13} cells. The cell population is not homogenous and is composed of diversity-rich heterogeneous cells differentiated from tissue stem cells. Such cellular diversity is important for the construction and maintenance of robust organs and tissues enduring environmental changes. So, it is speculated the collapse of the cellular diversity causes the onset and development of various diseases including cancer.

In this research project, we will clarify the basic principles of cellular diversity that are essential for the construction and maintenance of robust organs and tissues and their dysfunction in human disease through interdisciplinary collaborations among researchers who specialize in biology, mathematics, engineering, informatics and genomics. We will also develop novel mathematical models of cellular diversity and identify therapeutic targets for disease treatment.

Our research project consists of three research categories: A01 "Analysis of basic principles of cellular diversity", A02 "Mathematical analysis and modeling of cellular diversity" and A03 "Confirmation of mathematical model of cellular diversity". Through interdisciplinary collaborations of the members in this research project, we are expecting to put forward the cycle of biological studies, mathematical modeling and confirmation of cellular diversity using animal or organoid models, to elucidate the novel key molecules and pathways responsible for the onset and the progression of disease.

Based on the project design, we favor research proposals that can reinforce or synergistically promote the existing members' projects. For instance, we are seeking applicants who are investigating organogenesis and applicants who are developing real-time imaging systems that can visible in single-cell levels. We also welcome applicants who are trying to develop novel mathematical model. Those who will apply to the experimental research categories, i.e., A01 and A03, would be better to indicate whether their own researches fit either a highly-realizable fundamental experimental research or a challenging experimental research on the application form.

Research Category	Upper Limit of Annual Budget (Million yen per year)	Number of research projects scheduled to be selected
A01 Analysis of basic principles of cellular diversity	Fundamental experimental research: 6	3
A02 Mathematical analysis and modeling of cellular diversity	Challenging experimental research: 3	4
A03 Confirmation of mathematical model of cellular diversity	Theoretical research: 3	5

31 Brain information dynamics underlying multi-area interconnectivity and parallel processing

http://brainfodynamics.umin.jp/

Number of Research Area	:	4905	Term of Project :	FY2017-2021
Head Investigator	:	BITO, Haruhiko		
Research Institution	:	The University of Tokyo, Graduate School of Medicine		

The brain acquires information of the external world as multimodal sensory inputs and performs an enormous amount of information processing within and across areas, while compressing and storing it by appropriately transferring it between layers through parallel mechanisms. A central issue of today's neurobiology is to elucidate and reproduce the substance of this "brain information dynamics" using state-of-the-art techniques of measurement and manipulation and to decipher behavioral principles that rely on circuit-based mechanisms of memory, prediction, and decision-making. The aim of this Consortium Research Project is to establish a novel multidisciplinary research field, “brain information dynamics”, which encompasses a wide range of challenges from high-definition cytoarchitecture reconstruction to mapping of circuit models that define information transfer and storage in the brain, high-resolution measurement and manipulation of multi-areal network dynamics, and verification of computational models and theories leading to closed-loop control of recursive networks.

Research Group A01 Brain information decoding: We welcome proposals that will decipher basic circuit features related to higher brain function: basic cell type, connection motif, I/O conversion, and synaptic plasticity. Proposals that aim to apply novel computational approaches to decoding the brain information from massive experimental data are also welcome.

Research Group A02 Brain information recording: By performing functional cellular and circuit recordings through imaging and electrophysiology across a large number of cells, we will identify how information is expressed, transferred and converted in a variety of cell ensembles that communicate between multiple areas. We further welcome proposals that will develop innovative methods for the brain information recording taking advantage of state-of-the-art cell labeling, cell manipulation, and genome-editing technologies.

Research Group A03 Brain information network construction: By analyzing the fMRI signal from the human brain, we aim to tease apart how the brain higher-order functions emerge from communication between different cortical areas. We will consider proposals at the intersection of information science and bioengineering that will develop brain-inspired computing algorithms to be implemented in neural-circuit type hardware.

We welcome proposals that facilitate inter-group cooperation to achieve breakthroughs, and in particular, we encourage ambitious proposals from young and female researchers. For details of the research project, please refer to our website.

Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A01 Brain information decoding	3	7
A02 Brain information recording	3	7
A03 Brain information network construction	3	6

32 Creation of novel light energy conversion systems through elucidation of the molecular mechanism of photosynthesis and its artificial design in terms of time and space

http:// photoenergy-conv.net

Number of Research Area	:	4906	Term of Project :	FY2017-2021
Head Investigator	:	SHEN, Jian-Ren		
Research Institution	:	Okayama University, Research Institute for Interdisciplinary		

The energy and oxygen required for sustaining almost all life forms on the earth depend on photosynthesis performed by green plants and various algae. This project aims to elucidate the principles of natural photosynthesis at an atomic level, and to use the knowledge obtained from these principles for the development of artificial photosynthetic systems with a high efficiency of light energy conversion that may lead to the production of useful materials. In order to achieve this goal, we have organized a truly interdisciplinary team involving researchers from the fields of biology, biophysics, molecular biology, chemistry (inorganic, organic, synthetic, theoretical, and coordination chemistry), advanced photo-physics, and engineering, and will combine experimental studies with theoretical researches to elucidate the mechanism of photosynthetic water-splitting driven by visible light, the structures and functions of various protein complexes involved in light energy capture and transfer in natural photosynthesis. These studies will be combined with the studies aiming to develop artificial, highly efficient light energy capture, water-splitting, hydrogen production and carbon dioxide reduction systems. In order to promote the interdisciplinary researches between the fields of natural and artificial photosynthesis, advanced photo-physical instrumentations and theoretical approaches will be introduced to connect the researches in the two fields. The output of this project will significantly contribute to the acquisition of clean, renewable energy, thus help to solve the problems of energy shortage and global warming, two critical issues that our society is facing, or will face in the near future. Proposals covering the above areas but not included in the pre-defined research projects, especially those involving interdisciplinary researches, are welcome.

Research Group		Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A04	Elucidation of principles governing natural photosynthesis	3	14
B03	Elucidation of common principles of natural and artificial photosynthesis by means of advanced measurements and theoretical approaches	2	14
C03	Development of artificial photosynthetic systems		

33 Non-equilibrium-state molecular movies and their applications

http:// www.molmovies.med.kyoto-u.ac.jp

Number of Research Area	:	8101	Term of Project :	FY2019-2023
Head Investigator	:	IWATA, So		
Research Institution	:	Kyoto University, Graduate School of Medicine		

In order to understand the functions of biological macromolecules essential for life, it is most effective to capture their chemical reactions and structural changes in real time. X-ray free electron laser (XFEL) is a unique tool to observe these reactions and changes with outstanding time and spatial resolutions. Promote and develop this method as a versatile technology applicable to a wide range of biological macromolecules, we will integrate various methodologies including organic chemistry, computational science and biophysics to understand basic questions such as switching and signaling mechanisms of proteins and reaction mechanisms of enzymes. Based on these results, we will also develop controlling methods of biological macromolecules using light and other stimulations.

We call for proposals from researchers who develop basic technologies for making molecular movies (beamline science, chemical biology, protein engineering, etc.), and facilitate the use of molecular movie technology (biophysics, analytical chemistry, physical chemistry, etc.). We welcome the participation of researchers who will integrate diffent methodrogies. In particular, we encourage applications from computational scientists who will analyse the experimental results quantatively.

We also welcome applications from the researchers in fields such as biochemistry, molecular biology, structural biology, and synthetic chemistry, who are studying biological macrololecules or small molecule coumpounds where the molecular movie technique could address the detailed mechanisms of these systems. Since the research using XFEL is a very new interdisciplinary field of physics, chemistry and biology, we encourage applications from those who are totally new in this area. We also welcome proposals for developing new molecular tools in imaging, optogenetics, and optopharmacology.

Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A01 Structural Biology ad Chemical Biology	5	7
B01 Molecular Movie Platform Design	3	7
C01 Computational Chemistry and Spectroscopy		

34 Hyper-adaptability for overcoming body-brain dysfunction: Integrated empirical and system theoretical approaches

http:// http://www.hyper-adapt.org

Number of Research Area	:	8102	Term of Project :	FY2019-2023
Head Investigator	:	OTA, Jun		
Research Institution	:	The University of Tokyo, School of Engineering, RACE		

The goal of our research project is to elucidate the neural and computational principles of "hyper-adaptability." The hyper-adaptability is defines as the capability of central nervous system (brain and spinal cord) to manage impairment of sensory, motor and cognitive functions including ageing-related ones, by reactivating and recruiting pre-existing, latent but available networks. This capability is implemented by new computational principles and practical functions. We will approach this goal by linking neuroscience with systems engineering so that we could comprehensively understand fundamental mechanisms of acute / chronic impairments and disorders, and the principle of frailty.

We call for two-year research proposals of new groups shown below:

Research group A05 (corresponding to A01, A02, A03 and A04): neuroscience research in relation to hyper-adaptability, such as intervention studies on body cognition, sensori-motor, body structure, posture, emotion, memory, and those aiming at elucidating the mechanisms of hyper-adaptability in accordance with neurological disorders, development, or aging.

Research group B05 (corresponding to B01, B02, B03 and B04): systems engineering research in relation to hyper-adaptability, such as mathematical modeling studies on phenomena of hyper-adaptability by using data mining, machine learning, system identification, and model verification studies using brain activity analysis and motion analysis.

We encourage proposals on interdisciplinary study of neuroscience and systems engineering, and especially those of young researchers.

Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A05 neuroscience research on elucidation of phenomena and function of hyper-adaptability	3	10
B05 systems engineering research on elucidation of phenomena and function of hyper-adaptability	3	10

35 Integrated Biometal Science: Research to Explore Dynamics of Metals in Cellular System

http://bio-metal.org

Number of Research Area	:	8103	Term of Project :	FY2019-2023
Head Investigator	:	TSUMOTO, Kouhei		
Research Institution	:	The University of Tokyo, School of Engineering		

Several trace metal elements including iron, zinc, and copper play important roles in physiological functions such as energy conversion, material conversion and signal transduction. We call such metal and metalloid elements required to sustain life of all living organisms as "Biometal". Dynamics of Biometals *in vivo* such as their uptake, transport, sensing and utilization are strictly regulated, and its failure causes diseases. Some other metal elements are toxic, and their toxicity is emerged by perturbation of the dynamics of Biometal *in vivo*. In this project, our goal is to unravel the dynamics of Biometal *in vivo* comprehensively through all levels of biological organization and to establish a novel research field of "Integrated Biometal Science", in which the present research fields related to Biometal could be integrated. We will elucidate the strategy of living organisms, which was acquired during their evolution, to utilize effectively metal and metalloid elements for life and growth. Thus, "Biological Metal Element Strategy" will be established in this project.

In the research item A01, the functional roles of Biometal to maintain cellar homeostasis will be elucidated by studying the structure, interaction and function of proteins responsible for dynamics of Biometal *in vivo*. In the research item A02, the mechanisms of *in vivo* Biometal dynamics will be elucidated to develop its control method. In the research item A03, the mechanisms of development of toxicity of toxic metals will be elucidated in connection with *in vivo* Biometal dynamics. In the research item B01, measurement and analysis methods for Biometal research will be highly upgraded through collaboration with the project members in A01 ~ A03. We welcome challenging research proposals to contribute for the establishment and development of "Biometal Science" from researchers in various research areas including medical science, drug design, public health, computational science, and materials science in addition to the usual research fields relevant to Biometal.

Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A01 "Maintenance" of Bio-metal Dynamics	3	20
A02 "Failure" of Bio-metal Dynamics		
A03 "Disturbance" of Bio-metal Dynamics		
B01 "Measurement" of Bio-metal Dynamics		

36 Information physics of living matters

http://infophys-bio.jp/

Number of Research Area	:	8104	Term of Project :	FY2019-2023
Head Investigator	:	OKADA, Yasushi		
Research Institution	:	The University of Tokyo, Graduate School of Science		

Information or signaling has been one of the core concepts to understand the biological systems. Recent progress in technologies has enabled quantitative measurements of biological phenomena even at a single molecule level. However, theoretical framework(s) are still missing that can handle information in biological systems in a quantitative and unified manner. In this project, we aim at establishing a new interdisciplinary research field by applying this new information physics to biological systems. The theoretical frameworks of information physics will deepen our understanding of the biological systems. For example, we will be able to discuss the design principles of the existing biological systems through the quantitative analyses of their efficiencies, which will be enabled by the theoretical tradeoff relations among various (thermo) physical quantities and information. At the same time, many good model systems or interesting questions will be found in the real biological systems, which will stimulate the further development of the theory of information physics. We would build a research group to explore this new research field through active feedbacks between biologists and physicists.

We would welcome research proposals to widen research targets and approaches that are covered in this project.

D1: For the theoretical studies, we expect proposals not necessarily related directly to information thermodynamics, but other related topics such as information theory, control theory, learning theory, network theory, non-equilibrium physics, soft matter, stochastic process, dynamical system. Namely, we would welcome applications from various fields including information sciences, (bio)physics or mathematical sciences.

D2: The current biological targets in this project is very focused and limited. Therefore, we would welcome wide variety of proposals not necessarily limited to those related to information in a narrow sense or classical biophysical targets.

D3: We would also strongly welcome cross-disciplinary proposals that cover both theoretical approaches and experimental approaches. We also expect computational approaches or simulation studies in this category.

Since this project aims to explore a new research field at the interface of physics and biology, we strongly welcome ambitious, challenging proposals from young researchers, especially to cross the border between the two research disciplines.

Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
D01 Theoretical studies on information physics of living matters	3.5	6
D02 Experimental studies on information physics of living matters	1.5	12
D03 Cross-disciplinary studies on information physics of living matters		

37 Studies on intelligent systems for dialogue toward the human-machine symbiotic society

http://www.commu-ai.org/

Number of Research Area	:	8105	Term of Project :	FY2019-2023
Head Investigator	:	ISHIGURO, Hiroshi		
Research Institution	:	Osaka University, Department of Systems Innovation		

In the near future, home appliances and robots are expected to act autonomously. Humans and robots and appliances will communicate with each other through the use of language in order to understand each other's intentions and desires. As a result, symbiotic relationships between humans and robots and appliances will form. In order to realize a society in which there is such a symbiosis, this research will create a new academic area based on the following four planned areas of research: research that realizes the ability of robots to communicate and continue dialogue even when the content of the dialogue is not fully understood (A01), research that enables human-robot communication based on dialogue understanding and generation for specific purposes (A02), research that enables robots to build their own action decision models and estimate the interlocutor's action decision model (A03), research on the social impact of robots with intentions and desires, both through research on social norms in a symbiotic society and through demonstration experiments with people (A04).

In addition to the planned research groups, about 100 million yen per year is available for publicly offered research. This includes research on the implementation of intelligent systems and robots that interact with humans, and research on the humans involved with these interactive systems.

We will recruit 5 groups at a cost of 10 million yen each to employ postdoctoral researchers and research assistants to conduct publicly offered research, and 10 groups at a cost of 5 million yen each to conduct publicly offered research.

Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A01 Dialogue engagement and rapport research	10	5
A02 Communication understanding and generation research		
A03 Behavioral decision model estimation research	5	10
A04 Human-machine social norms research		

38 Post-Koch Ecology: The next-era microbial ecology that elucidates the super-terrestrial organism system

http://postkoch.jp/

Number of Research Area	:	8106	Term of Project :	FY2019-2023
Head Investigator	:	TAKAYA, Naoki		
Research Institution	:	University of Tsukuba, Faculty of Life and Environmental Sciences		

Earth's terrestrial ecosystems are sustained by the complex interactions of diverse organisms with each other and with their physical environment. In order to further elucidate the functionality of ecosystems, a new model of ecosystem dynamics that focuses on microbes should be developed to better reflect the abundance of microbes in the terrestrial environment and their interactions with a wide continuum of biological species. The overall goals of this research project are two-fold: to develop "post-Koch" techniques that enable the isolation and functional identification of new microbial species (Subproject A01), and to create a post-Koch ecology model based on functional informatics (Subproject A02). These goals will be achieved by the interdisciplinary application of engineering science, microbiology, ecology, and information science. Post-Koch ecology will help elucidate the principles of terrestrial ecosystem regulation and maintenance, which will in turn lead to innovative methods for sustaining and proactively improving the global environment.

Specifically, Subproject A01 aims to develop innovative post-Koch microbial techniques and use them to isolate unknown species that have not been detected by conventional methods. Interested scientists are invited to submit proposals on the following topics: (i) innovative techniques for microbial isolation, culturing, analysis, manipulation, etc., leveraging cutting-edge technologies such as fine processing, micro-electronic mechanical systems (MEMS), spectroscopy, and microscopic imaging; and (ii) discovery and functional analysis of new microbes and enhancement of their functional diversity. Subproject A02 intends to create a post-Koch ecosystem model by developing new bioinformatics techniques and by applying existing technologies from a new perspective. This subproject calls for creative proposals on the following topics: (i) mechanisms for the development of functionality in ecosystems involving microbe-microbe and microbe-plant interactions, (ii) integrated analysis of complex environmental and microbial data, and (iii) technologies for constructing large-scale microbial bioresources.

Both subprojects will give preference to ideas that include plans for experiments in the defined experimental farm available to this project, use the environmental and microbial data generated by the farm, and activate the entire project through interdisciplinary collaboration.

Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A01: Innovative post-Koch microbial techniques and their use to isolate unknown microbial species	4	6
A02: Post-Koch ecology model based on functional informatics	Experimental Research: 4 Informatics/Ecological Research: 3	4 3