

Research Area in Strategic Objective “*Research innovation through autonomous-driven research systems*”, “*Measuring “resilience of life” — Discovery and exploration of unknown biological response mechanisms*”, “*Development of innovative cell manipulation technologies and elucidation of cellular regulatory mechanisms*”, “*Elucidation of the mechanisms relating to changes in biological robustness associated with aging and control of age-related diseases*”, “*Toward scientific discoveries through DX in life science research*”, “*Integrated understanding of human multi-sensing networks and elucidation of their control mechanisms*”, “*Design of plant-derived molecules building up the foundation for plant synthetic biology*”, “*Functional dynamics in the cell*”

## **Life and Information**

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### **Overview**

Life sciences play a pivotal role not only in contributing to drug discovery and medical advancements for a healthy and long-lived society but also as a foundation for biotechnology essential for realizing a sustainable socio-economic environment. Recent research in life sciences has increasingly utilized information science, incorporating simulations based on physical models, theoretical approaches, and machine learning/AI with big data, alongside traditional experimental methods. The cultivation of researchers proficient in both life sciences and information science is urgently needed. It is imperative to support and nurture outstanding young researchers with innovative ideas spanning both research fields.

In this Research Area, we aim to integrate the two key concepts of "life" and "information", with a focus on fostering innovative research in life sciences utilizing information science. Our goal is to innovate research that involves machine learning/AI with big data, mathematical science, physical model-based simulations, and other information science. The diverse "data" dealt with in advancing research encompasses not only data generated from unique experimental results but also data obtained through collaborations and public databases. The research subjects include fundamental life sciences, for example, molecular and cellular biology, and biophysics, as well as applied challenges in drug discovery, medical sciences, and biotechnology.

In implementing research, we prioritize the development of researchers and emphasize the establishment of platforms for interaction and mutual inspiration among young researchers from

different research areas. Furthermore, efforts are actively made to build a broad human network that will facilitate future collaborations among researchers.

This Research Area participates in the Ministry of Education, Culture, Sports, Science and Technology (MEXT)'s Advanced Integrated Intelligence Platform Project on Artificial Intelligence/Big Data/IoT/Cybersecurity (AIP Project).

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

### **1. Background**

In the "Bioeconomy Strategy 2019" and "Integrated Innovation Strategy 2023," biotechnology is acknowledged as an essential foundational technology pivotal for cultivating a sustainable socio-economic system. The convergence of diverse research fields is expected to catalyze significant breakthroughs, especially through the exploitation of extensive research data acquired via cutting-edge measurement technologies and analytical techniques in across various hierarchical levels, from molecules and cells to organs and organisms.

This is deemed vital for the advancement of life sciences research and for enhancing Japan's future competitiveness. For this initiative, it is essential to pursue novel endeavors in the interdisciplinary field that spans 'life' and 'information', not solely relying on traditional experiment-centric approaches, but also exploring new attempts that have not been previously achievable. The integration of life sciences and information sciences is anticipated as a novel approach that can contribute to a deeper understanding of life sciences and offer hypotheses that may aid in solving the challenges of life science. It is essential to elucidate new features and mechanisms through approaches in computational science, such as machine learning and AI research using big data, simulations using physical models, and broadly, information science approaches, including mathematical and information engineering. To facilitate these innovative approaches, it is crucial to foster the development of the next generation of young researchers in the interdisciplinary domains of "life" and "information."

A significant initiative in this regard is the ACT-X program, which supports the establishment of originality among young researchers by promoting research grounded in unique and audacious ideas, under the themes of "life" and "information." The ACT-X program is dedicated to supporting young researchers who develop or innovate fields with creative and challenging ideas, leading to the creation of new values.

The designation "young researchers" within this research framework refers to individuals who are within eight years of receiving their doctoral degree or, for those without a doctoral degree, within thirteen years of earning their bachelor's degree (inclusive of graduate students), with allowances for any periods of maternity or parental leave.

## **2. Principle of invitation project and selection**

In this Research Area, we eagerly invite ambitious and challenging research proposals aiming to revolutionize investigations in the expansive realm of life sciences through the application of information science. This call encompasses inquiries across all facets of life sciences, spanning from basic research concerning molecules, cells, organs, organisms, and neuroscience to applied research in medicine, drug discovery, and biotechnology. It extends beyond human-centric studies to encompass investigations into a diverse array of life forms such as plants and bacteria. The scope of this initiative targets a broad spectrum of research areas, encompassing not only studies analyzing vast datasets through bioinformatics, machine learning, and AI, but also information science employing physical models for simulation, data assimilation integrating both big data and physical models, and theoretical inquiries based on mathematical models.

For the advancement of life sciences through information science, a profound comprehension of the significant unresolved issues in life sciences, coupled with expertise in state-of-the-art information science technologies, is indispensable. The copious amounts of data generated in life sciences harbor much unknown information, and their effective utilization can unveil novel features and insights not discernible through conventional approaches in life sciences. For issues beyond the resolution of experimental data alone, research in computational science via large-scale simulations, methodologies assimilating big data with physical models utilizing Bayesian statistics, and theoretical constructs grounded in mathematical models from a physics perspective prove to be efficacious. Although this Research Area encompasses a wide array of information sciences, proposals must center on inquiries in life science research and their applications in biotechnology, drug discovery, and medicine.

The data addressed in this Research Area encompass not only those derived from unique experiments but also data from collaborative research with experimental life scientists and from public databases. In collaborations (such as deepening the analysis of measured data through information science or dissemination via databases), the primary focus of support is on research projects that analyze data using information science methodologies, rather than on generating data through experiments. While research proposals utilizing data obtained from experiments conducted by

experimental researchers are certainly welcomed, emphasis is placed on the importance of proposing ambitious research endeavors. These projects necessitate proposals that not merely apply existing analytical methods, but rather incorporate innovative analyses from the perspective of information science.

The interdisciplinary research perspective gained through the implementation of ACT-X aids subsequent investigations. Throughout the research period, it is crucial not only to advance the proposed research and technological developments but also to explore novel methods of information retrieval within the diverse realm of "data" and the applicability of information science methodologies across different domains through interaction with Advisors and peers in the field. We welcome proposals from ambitious researchers who harbor their own unique perspectives and novel ideas, aiming to expand their boundaries as researchers through ACT-X.

### **3. Research periods and research funds**

The duration of the research period shall be limited to a maximum of two years and six months, with a standard budget of approximately 4.5 to 6 million yen (excluding indirect costs). When there should be a necessity for the total research budget to exceed 6 million yen, the reasons for this must be clearly articulated in the proposal (up to a maximum of 10 million yen). Additionally, awardees will undergo a progress evaluation approximately two years after the commencement of their research. For projects deemed likely to yield significantly greater outcomes with continued support, an additional one-year extension of support will be provided in what is referred to as the acceleration phase. It should be noted that the number of projects to be accepted is anticipated to be around 20, although this figure may vary depending on the budgetary situation and the research budgets of the accepted proposals.

If a graduate student is accepted, it is possible to apply for their own Research Assistantship (RA) expenses, in addition to the aforementioned research funds.

### **4. Principle of Research Area management**

In this Research Area, we actively promote interactions among ACT-X researchers from diverse research fields encouraging interdisciplinary collaboration.

ACT-X is crafted with the anticipation that young researchers, including those pursuing graduate degrees, will embark on ambitious research projects, fully aware of the risk of the inherent challenges such endeavors entail. Nonetheless, the funding allocated for individual research initiatives is limited.

Applicants are encouraged to consider the utilization of shared facilities at their institutions or existing equipment in their laboratories when proposing the research projects. In the field of information science, innovative ideas based on the unique perspectives are essential. Proposals closely related to large projects conducted in laboratories, etc., require a detailed explanation of the research proposal, emphasizing the applicants' new ideas and unique perspectives.

Moreover, within this Research Area, each ACT-X researcher will be paired with Research Area Advisors who is a distinguished expert actively contributing to their research field. Subject to the preferences of ACT-X researchers, we aim to institute a framework for scholarly discourse. Additionally, Research Area Meeting will be organized, convening the Research Supervisor, Research Area Advisors, and ACT-X researchers to stimulate scholarly interaction. We also anticipate the development of cross-disciplinary group research from the network built by diverse young researchers. ACT-X researchers are expected to actively engage in international conferences and workshops to fully understand the latest trends worldwide, with the aim of pursuing further original research. Our goal is to focus on research freely and openly without being overly concerned with short-term outcomes or outreach, ensuring that graduate students and researchers at various life stages can easily participate in the management of this Research Area.

This Research Area, as a member of Advanced Integrated Intelligence Platform Network Laboratory (AIP Network Laboratory) that constitutes MEXT's AIP project (on Artificial Intelligence/Big Data/IoT/Cybersecurity), contributes to the research collaboration activities with the RIKEN Center for Advanced Intelligence Project and other related research institutions.