

Summary of Research Center Project

*Briefly describe the general plan of your project (Compile in English within 2 pages.)

Center name:	International Research Center for Neurointelligence
Host institution:	The University of Tokyo
Head of host institution:	Teruo Fujii, President
Center director:	Takao Kurt Hensch, Project Professor, International Research Center for Neurointelligence
Administrative director:	Nobukazu Toge, Project Professor, International Research Center for Neurointelligence

1) Overall Image of Your Center

The International Research Center for Neurointelligence (IRCN) seeks an advanced understanding of human intelligence (HI) through the elucidation of basic principles underlying neural circuit development and the pathology of psychiatric disorders caused by anomalies in this process. In turn, we aim to promote next-generation artificial intelligence (AI) based on these principles of neural circuit maturation and function in the brain. To this end, IRCN will establish "Neurointelligence" as a new discipline by merging research areas in life science, medicine, mathematics/information science and linguistics.

2) Research Activities

<Importance of the subjects>

HI represents the most complex higher-order functions based on the operation of neural circuits in the brain. These emerge through multiple molecular/cellular processes in fetal and postnatal life, reflecting both innate genetic programs and individual experience. Neural circuits in the visual areas of the cerebral cortex have provided a rich model for the hierarchical neural networks used in deep learning instrumental for the recent development of AI. Nevertheless, the vast majority of information processing principles in actual neural circuits have yet to be clarified and are crucially needed to establish next-generation AI. Anomalies in neural circuit development are generally accepted as the root of human cognitive disorders, including autism spectrum disorder (ASD) and schizophrenia. IRCN therefore sets the following as its research goals: systematically combining basic research on developmental principles for the formation of flexible and synergistic neural circuit representations that engender HI; promoting next-generation AI based on these principles; and overcoming mental illness due to anomalies of neural circuit development

<Research organization>

IRCN takes a **Team Science** approach to research fusion combining sixteen world-class principal investigators (PIs) spanning four domains of research. In the area of **Neurodevelopment**, selected model systems elucidate the fundamental principles of neural circuit development: Yukiko Gotoh (prenatal stem cell fate); Masanobu Kano (synapse elimination in postnatal development); Kazuo Emoto (elimination and remodeling of dendrites); Kenichi Ohki (activity-dependent neural circuit development); Yoko Yazaki-Sugiyama (birdsong learning). In the area of **Human/clinical** research, psychophysical, non-invasive imaging and patient cohort studies establish valuable insight into human brain

development and dysfunction: Sho Tsuji (infant language acquisition); Takao Hensch (perinatal critical periods & autism); Kiyoto Kasai (adolescent critical periods & psychosis); Zenas Chao (prediction & creativity). In the area of **Computation**, neuro-inspired mathematical principles focused on brain dynamics will be pursued: Kazuyuki Aihara (dynamical network biomarkers & neuromorphic hardware); Mingbo Cai (prediction); Takamitsu Watanabe (energy landscape modeling & autism); Yukie Nagai (developmental robotics). Novel **Technology** will advance state-of-the-art neural circuit analysis: Haruo Kasai (reinforcement learning & synaptic plasticity); Yasushi Okada (neuronal imaging); Shoji Takeuchi (biohybrid sensors). Multiple teams are formed “bottom-up” by intentionally combining PIs across these four areas, such as Social Learning, Critical Period Timing, Prediction, Reinforcement, Intrinsic Activity, Multiscale imaging, Autism or Psychosis.

IRCN also incorporates an extensive group of senior Affiliated Faculty (AF) and junior Associate Research Fellows (ARF), as well as an international network of over twenty partners, starting with a satellite unit at Boston Children’s Hospital (Harvard University), to complement the work at UTokyo. Notably, IRCN includes large clinical centers in Tokyo and Boston for active translational research, which cannot be easily achieved at other brain science institutes without clinical branches.

3) Interdisciplinary Research

Interdisciplinary cooperation is a prerequisite for understanding both highly complex brain functions and their pathology due to neurodevelopmental dysfunction. Few interdisciplinary research centers are designed to promote collaboration amongst globally-renown basic neuroscientists, clinicians and mathematicians with a long-term goal of understanding how HI arises to inspire next-generation AI. Thus, IRCN should emerge as a world-leading research center with a unique scientific mission and profound social impact. Trainees will benefit from multiple co-mentors across disciplines.

4) International Research Environment

IRCN supports foreign scientists to adapt to the grant system in Japan (including grant writing and management of accepted grants), while reducing hurdles associated with daily life, by a multi-lingual secretariat. Center Director Hensch has a long track record of creating mechanisms to welcome foreign staff to Japan, as well as building a pipeline for students from abroad. IRCN sponsors both large-scale international symposia domestically and abroad, and supports smaller-scale meetings and workshops to promote researcher exchange between IRCN Teams, satellites and partner institutions.

5) Center Management

The center Director is given full authority regarding organization and management of the Center. He sets the mission and goals of IRCN, effective organization of researchers, administrative decisions, and recruitment of scientists. Alongside the Director, the Administrative Director (AD), General Manager (GM), Special Advisor (SAD) and Executive Director (ED) form the Directorate’s Office (DO) to provide daily administrative services necessary for the execution of IRCN activities. Three Deputy Directors (DD) support the Director for smooth operation and swift decision making, and all PIs form the Steering Committee (SC) responsible for approving the Director’s decisions and their execution.