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:	Makoto Gonokami, President
Prospective Center director:	Takao Kurt Hensch Professor of Molecular Cellular Biology at Harvard University Professor of Neurology at Harvard Medical School
Prospective Administrative director:	Tetsushi Kagawa Project Professor of Research Enhancement Strategy Office at National Institute for Physiological Sciences

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 a 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 neural circuit development, pathological studies on psychiatric disorders, and innovative AI research; elucidating 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 will be composed of four core research units lead by fifteen world-class principal investigators (PIs). In the Development Study Unit eight PIs, including the center director Takao Hensch, will focus on selected model systems to pursue the fundamental principles of neural circuit development: Yukiko Gotoh studies regulation of neural stem cell fate; Masanobu Kano, synapse elimination in postnatal development; Kazuo Emoto, elimination and remodeling of dendrites; Rachel Wong, neural circuit formation in the retina;

Takao Hensch and Kenichi Ohki, neural circuit development in the cerebral cortex; Haruo Kasai, reinforcement learning for association between sensory-motor and emotion signals; and Kuniyoshi Sakai, mechanisms in human language information processing. In the Technology Development Unit, Yasushi Okada, Haruo Kasai, Arthur Konnerth, and Shoji Takeuchi will advance state-of-the-art neural circuit analysis technology. In the Neurodevelopmental Disorder Pathology Unit, Kiyoto Kasai will use human structural and functional MRI to elucidate ASD and schizophrenia pathology, while Takao Hensch will pursue novel, circuit-based etiological insights and treatments for these cognitive disorders using preclinical models. In the Mathematical Information Systems Unit, Hiroki Ueda will investigate the regulation and principles hidden beneath complicated biological phenomena, using both mathematical analyses and his original brain clarification technique; Kazuyuki Aihara and Masashi Sugiyama will create next-generation AI technology based on the newly elucidated principles of neural circuit development in the brain.

IRCN also incorporates satellite units at Harvard University and the Max-Planck Florida Institute for Neuroscience. Importantly, IRCN includes large clinical centers in Tokyo and Boston for active translational research, which cannot be achieved by other brain science institutes without clinical branches.

3) Interdisciplinary Research

Interdisciplinary cooperation is a prerequisite for understanding highly complex brain functions and elucidating pathology of disorders due to their dysfunction from a neurodevelopmental perspective. There are few interdisciplinary research centers designed to promote collaboration between globally-renowned basic neuroscientists, physicians, and AI researchers with a long-term goal of understanding HI and creating next-generation AI principles. Thus, IRCN would become a world-leading research center with unique scientific mission and profound social impact.

4) International Research Environment

IRCN will support foreign scientists to adapt to the grant system in Japan (including grant writing and management of accepted grants), alongside reduced 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 will sponsor large-scale international symposia every year, and support smaller-scale meetings and workshops to promote exchange of researchers among the core IRCN units, its satellites and other institutes.

5) Center Management

The center Director is given all authority regarding organization and management of the center. His roles include: setting the mission and goals of IRCN, effective organization of researchers, administrative decisions, and recruiting scientists. The Administrative Director (AD) cooperates with the Director and provides administrative services necessary for the execution of IRCN activities. Two Deputy Directors support the Director for smooth operation and swift decision making, and all PIs are responsible for approving the Director's decisions and their execution.