MultiSensing

Integrated understanding of multi-sensing networks and elucidation of their control mechanisms leading to the innovation of medical technologies

Research and Development Objectives

Integrated understanding of human multi-sensing networks and elucidation of their control mechanisms

This Objective aims to develop an integrated understanding of multi-sensory systems, including sensory systems and peripheral nerve networks, and to develop methods to visualize and control these systems. Specifically, this Objective aims to achieve the following:

(1) Understand peripheral neural circuit mechanisms and clarify disease pathology to help overcome disease
(2) Develop methods to visualize and control peripheral nerve activity and new treatment methods
(3) Clarify and apply the mechanisms involved when sensory systems receive, process, and act on signals
(4) Develop technology platforms for methods to visualize and control sensory systems

Program Supervisor (PS)

NAGAI Ryozo
President,
Jichi Medical University

Program Officer (PO)

TAKEUCHI Shoji
Professor, Graduate School of Information Science and Technology,
The University of Tokyo

Program Officer (PO)

NISHIDA Kohji
Professor, Graduate School of Medicine, Osaka University

Advisor

OKADA Yukinori
Professor, Graduate School of Medicine, The University of Tokyo

OKABE Shigeo
Professor, Graduate School of Medicine, The University of Tokyo

OGAWA Yoshihiro
Professor, Graduate School of Medical Sciences, Kyushu University

SAKURADA Kazuhiro
Professor, School of Medicine, Keio University

SEKITANI Tsuyoshi
Professor, SANKEN, Osaka University

TAKAI Madoka
Professor, School of Engineering, The University of Tokyo

TAKEDA Kiyoshi
Professor, Graduate School of Medicine, Osaka University

TSUKADA Shingo
NTT Fellow, NTT Basic Research Laboratories, Nippon Telegraph and Telephone Corporation

HIRAMATSU Ryuji
Visiting Director, Foundation for Biomedical Research and Innovation at Kobe

FUJIYAMA Fumino
Professor, Graduate School of Medicine, Hokkaido University

MANABE Ichiro
Professor, Graduate School of Medicine, Chiba University

MITSUKURA Yasue
Professor, Graduate School of Science and Technology, Keio University

YONEDA Yoshihiro
Director, The Research Foundation for Microbial Diseases of Osaka University

AMED-CREST Started in 2021 · 1st period

Elucidation of roles and functions of neural network underlying intractable hematologic disorders in aged bone marrow and building of new technology platforms for nervous system-targeting clinical applications

KATAYAMA Yoshio
Junior Associate Professor,
Hematology, Kobe University Hospital

The healthy service life of bone marrow is approximately 50 years, and along with the age, the incidence of particular intractable hematologic disorders, each of which displays unique alteration of bone metabolism, rapidly increases. The aim of this research is to elucidate the alteration in the network of nervous—skeletal—hematopoietic systems, develop neural activity based-biomarkers for disease status and prognosis, and identify new pharmacological targets for development of therapeutic drugs for aged marrow-based hematologic malignancies as new technology platforms for nervous system-targeting clinical applications.

Integrated understanding of functional asymmetry of the autonomic nervous system and development of electrical nerve stimulation to treat cross-organ disorders

KANAI Takanori
Professor,
School of Medicine, Keio University

The organism is a collection of organs that control cognition, nutrient absorption, circulation, immunity, and metabolism. To unite these independent biological processes, organ-organ interactions are essential for the organism to function. This project focuses on the functional asymmetries of the autonomic nervous system and aim to clarify how the interaction between the gut and the brain impacts on higher brain functions. Furthermore, we plan to develop super-selective vagus nerve stimulation techniques as new treatment strategies for visceral and central nervous system diseases such as inflammatory bowel disease and multiple sclerosis.

Theoretical basis for human clinical application of sensory medicine

KOBAYAKAWA Ko
Professor,
Institute of Biomedical Science, Kansai Medical University

Organisms have protective abilities to survive crisis situations. However, medical technology to artificially induce these abilities has not yet been developed. We found that thiazoline-related innate fear odors bind to TRPA1 in sensory nerves and activate the crisis response center in the brainstem-midbrain, thereby increasing survival rates in lethal environments and pathological models. In this research, we aim to elucidate the principles by which TRPA1 distinguishes agonists to induce distinct responses and the principles by which the brain center integratively induces protective effects, in order to achieve early practical application of sensory medicine.

Age-related hearing loss: analysis of the pathological mechanisms and development of a technological basis for next-generation therapeutic interventions

HIBINO Hiroshi
Professor,
Graduate School of Medicine, Osaka University

Age-related hearing loss lowers quality of life and increases risk for dementia and depression. This disease stems primarily from damage of the cochlea in the inner ear, and the pathological processes remain largely uncertain. In this project, we will analyze the cochleae of animal models by multiple approaches including a cutting-edge imaging technology and clarify the mechanisms underlying age-related hearing loss. Using such observations, we will provide technical basis for preventive and therapeutic medicine and prototypes of a next-generation cochlear implant. The outcomes may contribute to extension of healthy life.

Development of neuroscience based intelligent neuromodulation system for complex regional pain syndrome (CRPS)

HIRATA Hitoshi
Professor, Innovative Research Center for Preventive Medical Engineering, Nagoya University

The objectives are to investigate the pathological mechanism underlying the multi-sensing network failure in patients with complex regional pain syndrome (CRPS) using advanced neuroscience technologies, and to develop an innovative neuromodulation technology to restore normal conditions within the nervous system by deploying a specially developed multi-channel nerve stimulator, original artificial intelligence and unique sensor technologies. This will be undertaken by 3 groups, each having responsibility for a core project yet in close interdependent collaboration with the others. The goal is to develop a multi-faceted innovative neuro-modulation system that addresses the multiple nervous systems involved in the pathological mechanism of CRPS.pathological mechanism of CRPS.

Establishment of therapeutic strategies for neurodevelopmental disorders through an integrated understanding of brain-sensing networks focusing on retinal circuit function

FURUKAWA Takahisa
Professor,
Institute for Protein Research, Osaka University

Neurodevelopmental disorders (NDs) including autism spectrum disorder (ASD) and attention deficit hyperactivity disorder (ADHD) have become one of the important social issues worldwide. Recently sensory abnormalities (atypical sensory features) in NDs have gathered an increasing attention, because NDs, especially ASD, are often accompanied with atypical sensory features. In the present R&D proposal, we aim to elucidate multi-sensing-brain relationship by analyzing the effect of a specific retinal pathway defect on sensory and brain functions. Furthermore, we aim to develop a novel visual stimulation-mediated therapeutic device to ameliorate symptoms of NDs including ASD.

AMED-CREST Started in 2022 · 2nd period

Understanding of light multi-sensing by non-visual opsins and development of novel light therapies

KURIHARA Toshihide
Associate Professor,Department of Ophthalmology,
Keio University School of Medicine

Non-visual opsins are also expressed in the retina and other tissues, and control various multi-sensing mechanisms other than visual signals. Our study aimed to verify whether the non-visual opsins (OPN3, OPN4, OPN5) in the eye are involved in the suppression of myopia progression toward the development of novel treatments for myopia. Then, we shed light on the neural circuits of opsins that control the ocular tissues and develop ligands other than light that intervene in opsin activity or circuits. From our study, a paradigm shift will be expected in understanding light sensing systems other than the vision with the eyes.

Study of the mechanism for integration of multi-sensing systems by emotion and the development of innovative therapy for pain

MINAMI Masabumi
Professor,Faculty of Pharmaceutical Sciences,
Hokkaido University

How diverse sensory information is integrated to generate negative emotions such as aversion, anxiety, fear, and depression remains unclear. In this study, we will focus on the neural circuits centered on the extended amygdala to elucidate the mechanisms for integration of diverse sensory information and for emotion-mediated interaction mechanism between sensory information of different modalities. We also aim to develop an innovative pain treatment method that improves patients' quality of life (QOL) and social activity by removing anxiety, fear, and "captivity" to pain through exercise and successful experience in a virtual space.

Identification of the malignant loop for the brain disorder involving endocrine and neuronal functions

MURAMATSU Rieko
Director,
National Center of Neurology and Psychiatry

This study aims to elucidate how a multilevel network of the brain and peripheral organs causes brain disorders. Until now, most researches on the pathological mechanisms of brain diseases have focused on elucidating the roles of cells and molecules in the brain. This study will focus on the role of peripheral environment that affects brain disorders, and will show the evidence that the malignant loop formed between the brain and peripheral environment is a major mechanism for the progression of brain disorders. We also aim to develop therapeutic approaches for treating brain disorders by intervening in the malignant loop.

Research and development of next-generation retinal prosthesis device based on the development of innovative BMI technology and understanding and controlling visual cognitive networks

MORIMOTO Takeshi
Associate professor,
Osaka University Graduate School of Medicine

Retinal prosthesis is a device to reconstruct vision by implanting an electrode array in the eye of a blind patient. The current retinal prosthesis gives patients hope of seeing, but it is inadequate for daily life. In this project, we will research and develop a new retinal prosthesis device by developing an internal device with dramatically improved performance using innovative BMI technology, an external device that can effectively project visual information through information processing, and by understanding and controlling visual cognitive networks. The goal is to enable patients to read and perform daily activities at home as well as normal people.

AMED-CREST Started in 2023 .... 3rd period

Perinatal drug discovery based on multi-sensing network between mother and child via sex steroid hormone

KIMURA Ikuo
Professor,
Graduate School of Biostudies, Kyoto University

Sex steroid hormones are involved in many physiological functions. Most of them involve immediate responses that cannot be explained by the nuclear receptors, and the mechanisms are still unclear. In this research, we focus to sex steroids that rapidly increase in mother during pregnancy. Based on our novel finding that the novel membrane progesterone receptors (mPRs) are highly expressed in various sensory tissues of the fetus during the late stages of pregnancy, we aim to unravel the molecular mechanisms. Additionally, by developing mPRs-selective compounds, we aim to divide the various functions of sex steroids and to treat perinatal disorders.

Development of novel therapeutic strategy for chronic kidney disease based on understanding of responses to mineral stress

KUROO Makoto
Professor,
Division of Anti-aging Medicine, Jichi Medical University

Phosphorus is one of the 6 elements essential for life. In vertebrates, phosphorus exists as phosphate and is stored predominantly in the bone in the form of calcium-phosphate. However, when precipitated ectopically besides the bone, calcium-phosphate induces inflammation and cell senescence, potentially accelerating aging. In the blood and urine, calcium-phosphate exists as colloids called calciprotein particles (CPP). We define (patho)physiology that involves CPP as responses to "mineral stress". Our long-term goal is to explore novel anti-aging medicine based on a better understanding of molecular mechanisms underlying mineral stress.

Elucidation of the mechanisms for pain generation and modulation by stress and development of diagnostic and therapeutic technologies for chronic pain

TSUDA Makoto
Professor, Graduate School of Pharmaceutical Sciences,
Kyushu University

The relationship between chronic pain, which afflicts many people in Japan, and physical/mental stress has attracted attention. In this study, using advanced neural circuit labeling/manipulation techniques, we aim to identify brain regions critically involved in pain generation/modulation, analyze the effects of stress, and clarify the brain regions and neural circuits responsible for stress-related chronic pain. Based on these findings, we aim to develop new diagnostic and therapeutic strategies for chronic pain.

PRIME Started in 2021 .... 1st period

The generation of human taste organoids and their characterizations as taste sensors

IWATSUKI Ken
Professor,
Tokyo University of Agriculture

Although we have been analyzing taste cells using the mouse or monkey taste stem cell culture system, it became clear that humans have different taste preference from other animals. Therefore, in this study, we expect to generate human taste organoids so that we will be able to analyze taste cell function that is peculiar to humans. In the future, we hope to contribute to the new drug development and regenerative medicines using human taste organoids.

Development of somatosensory prosthesis with reference to somatosensory processing in the brain

UMEDA Tatsuya
Associate Professor,
Graduate School of Medicine, Kyoto University

Brain-machine interface (BMI), which directly connects brain and machine, has the potential to improve the quality of life for patients suffering from brain or spinal cord injuries, because they can operate a prosthesis or machine based on brain activity. However, the poor performance in the somatosensory prosthesis is a problem in the practical use of BMIs. This study will develop a somatosensory prosthesis that can elicit shape perception by activating the primary somatosensory cortex with electrical stimulation with a pattern that is designed based on the somatosensory processing in the brain during active exploration of the hand.

From vision to hippocampal cognitive map: underlying circuit mechanisms

KITANISHI Takuma
Associate Professor, Graduate School of Arts and Sciences, The University of Tokyo

When we visit a new place, we look around to get a sense of where we are. As we know from these experiences, vision is the key to support spatial cognition. However, how visual information is transmitted and converted into spatial representations in the hippocampus and its associated areas remains unclear. This study will uncover the neural circuit mechanism that converts visual information to hippocampal spatial representations by using large-scale neural recordings and novel optogenetic techniques.

Regulation of temperature acclimation by integration and modulation of multi thermosensory information

KUHARA Atsushi
Professor, Konan University

Since temperature is one of the environmental information that is directly linked to animal's lives, malfunction of thermo-sensing and its information processing causes various diseases. In this study, we aim to elucidate how multi-thermosensory information received at multiple locations in the body or in a single cell are integrate or discriminate to regulate temperature acclimation in the body. We also aim to elucidate how sensory information other than temperature affects the temperature signaling on neural circuit. These studies will be conducted using nematode C. elegans, a model animal that allows for high-throughput analysis.

Response mechanism of skin sensing system to mechanical stress

KOBAYASHI Tetsuro
Deputy Team Leader, RIKEN IMS

The skin is a barrier organ organized by an epithelial-immune network, and disruption of the crosstalk leads to the development of various diseases. This project will reveal a skin sensing system constructed by the interaction between epithelial sensors that receive mechanical stress and immune cells that act as responders. We aim to understand the pathogenesis of atopic dermatitis, which is aggravated by persistent mechanical stimuli such as scratching behavior, and to develop novel therapeutic strategies.

Establishment of a novel pain evaluation system using nerve organoids derived from human iPS cells

SHIBATA Shinsuke
Professor, Graduate School of Medical and Dental Sciences, Niigata University

Among various biological sensing systems, abnormal pain sensation produced a largest number of patients and induced the lowest QOL (quality of life). Many studies were conducted to analyze the mechanism of pain development, but most of the studies analyzed based on subjective evaluation criteria. In this project for the multi-sensing network program, we will develop objective and quantitative pain-sensing devices by combining the advanced imaging technology with using various kinds of microscopes, the precise skills for the molecular biological analysis, and the sophisticated technologies of machine engineering specialists for developing special culture devices.

Developing somatosensory system on a chip toward novel pain control method

SHIMBA Kenta
Associate Professor, School of Engineering, The University of Tokyo

Developing a novel treatment for neuropathic pain requires comprehensive understanding of dynamics in the relevant neural networks. In this study, somatosensory networks including pain processing circuits will be reconstructed on a chip using microfabrication technology. With precise optogenetic stimulation and extracellular recording of the network, we aim to elucidate the neural basis for pain transmission and amplification in pathological conditions. Furthermore, we will explore the possibility of novel pain control methods using the integration of multisensory information.

Study of whole-body humidity sensing mechanisms via skin humidity receptor

CHIKUMA Mariko
Associate Professor, School of Medicine, Keio University

The ability to detect and sense variation in humidity is important for terrestrial animals to protect the body from the environment. However, the cellular and molecular basis for hygrosensation and the genes involved in detecting humidity remain unknown. The aim of this study is to investigate how the skin senses variations in humidity consequently controlling the whole-body. We will identify the "humidity sensor" expressed in the skin and examine the mechanism controlling the sensing, response, and transmission of humidity stress in the skin and the whole body. The findings may establish the underlying mechanism of skin-mediated whole-body sensing networks of humidity stress.

Deciphering the mechanism of impairment in homeostatic energy metabolism regulated by brain and finding the way to improve it

TODA Chitoku
Associate Professor, Department of Neuroscience for Metabolic Control, Faculty of Life Sciences, Kumamoto University

The brain monitors the amount of nutritional energy in the body and environmental food availability by multi-sensing systems. Animals change feeding behavior and energy utilization according to these internal and external situations. Obesity attenuates the function of multi-sensing systems and thus leads to diabetes. Our project is to clarify how our brain integrates a wide variety of inputs from both inside and outside of the body. We also try to understand the mechanism by which obesity impairs the multi-sensing systems. Our project will develop a way to improve the impaired sensing systems.

Elucidation of homeostatic mechanism and its failure mechanism by new sensing and integration mechanism of cardiovascular stress

FUJIU Katsuhito
Professor, The University of Tokyo Hospital

The heart and blood vessels are subject to various stresses. These stresses are integrated into the brain and multiple organs via peripheral nerves and humoral factors. In addition, the system keeps circulatory control homeostatic. In this study, I will treat various cells that make up the brain and nervous system and investigate how the brain and nervous system sense and control cardiovascular stress. Furthermore, we will elucidate when the disease develops beyond being able to overcome the burden.

Pain & loneliness: Neural basis for sociality formation through peripheral nociception tuning

ISHII Kenichi
Assistant Professor,
Graduate School of Science, The University of Tokyo

Loneliness, or lack of social interactions among individuals, often leads to pathogenic sensation of physical pain. Moreover, nociception abnormalities in autism spectrum disorder (ASD) patients are epidemiologically linked with impaired interpersonal relations. Here I propose to use fruit fly as a genetically tractable model to unravel the neurogenetic mechanism of peripheral nociception tuning and its potential importance in animal/human sociality formation. The present study further aims to provide mechanistic insights for the ASD-related pathologies in nociception.

The neural circuit of multisensory integration and emotion in eating behavior

OZAWA Takaaki
Assistant Professor,
Institute for Protein Research, Osaka University

Food palatability is generated by the complex synergy among perception from multiple senses during a meal, such as taste and odor. However, neural circuit mechanisms through which a taste generates food palatability, or an aroma promotes the food palatability remain largely unknown. This study aims to elucidate the neural systems that integrate multisensory information and convert them into positive emotions by taking advantage of cutting-edge neuroscience tools. Results of this research will contribute to solving health problems related to our eating behavior, which may improve our quality of life (QOL).

Study of multisensory integration in pathological cascade in neurodegeneration

SHIMOJO Masafumi
Principal Researcher, National Institutes for
Quantum and Radiological Science and Technology

The dysregulation of the sensory integration process is currently proposed as a key component in the pathophysiological cascade of various neurological disorders. However, the disease-associated mechanism is still largely unknown due to the lack of appropriate methods to monitor the dynamics of circuit reorganization in the brain network of living animals. This project aims to establish genetic and neuroimaging technologies for the analysis of multisensory integration in the brain of animal models for tauopathy. Furthermore, we will also explore the possibility to modify the pathophysiological progress of neurodegenerative disorders.

Characterization of ether lipids in multi-sensory processes and the oxidative stress-induced dysfunction

SOKABE Takaaki
Associate Professor, Exploratory Research Center on Life and Living
Systems, National Institutes of Natural Sciences

The countermeasures to maintain our sensory functions are demanded for elongation of healthy life expectancy, however, the mechanisms underlying sensory defects caused by aging and chronic diseases have not been elucidated. We are focusing on lipid molecules that participate in the sensory processes and will investigate their regulatory roles, and also clarify how oxidative stress during progress of aging and diseases deteriorates lipid-mediated sensory functions. We will strive to improve impaired sensory functions and establish the methodologies that are beneficial for increasing quality of life(QOL) in the longevity society.

Non-invasive, spatiotemporal control of internal organs via sonogenetic stimulation of the autonomic nervous system

TAKEUCHI Yuichi
Professor,
Faculty of Pharmacy, Kindai University

Ultrasound can not be heard by humans and is considered a suitable modality for non-invasive neuromodulation due to its transmittability in our body, spatio-temporal specificity, and safety. In this study, I will develop a new technology to precisely control cardiac functions via ultrasound-sensitive ion channels exogenously expressed in sympathetic and parasympathetic nuclei in the medulla of rats. This research will provide a seed for an innovative medical technology that precisely controls visceral functions in a spatiotemporal specific manner via an all-non-invasive pipeline from gene transduction to functional regulation.

Reno-protective/anti-inflammatory mechanisms via neural circuits activated by various stresses/stimuli

TANAKA Shinji
Assistant Professor, Division of Nephrology and
Endocrinology, The University of Tokyo Hospital

Anti-inflammatory effects via neuro-immune interactions are promising novel treatment strategies for inflammatory disorders in many organs. Inflammation plays a critical role in the pathophysiology of kidney disease; however, little is known about the role of neuro-immune interactions in kidney disease. In this proposed research, we will elucidate anti-inflammatory and reno-protective mechanisms via neural circuits activated by various stresses and stimuli, which can lead to a novel strategy for the treatment of kidney disease.

Study of neuronal networks for the sub-second timing perception

HASHIMOTO Kouichi
Professor,
Hiroshima University

Time perception is an important sense for animals. A certain type of the time perception is initiated by a sensory input and perceived as the elapsed time from the sensory input. We plan to analyze the neuronal networks working for such sensory-driven timing task in the sub-millisecond range. We will particularly focus on the contribution of the cerebellar networks.

Elucidation of diverse innervation in the stomach that senses luminal and psychological stress and its relationship with gastric diseases

HAYAKAWA Yoku
Lecturer,
The University of Tokyo Hospital

There are a large number of patients with gastric diseases in Japan, and chronic gastritis is a serious clinical problem since it causes gastric ulcers and cancers. The stomach contains abundant nerves, and while it transmits stimuli from intraluminal stressors to the brain, it also transmits signals from central nervous system activated by mental stress into the stomach. In order to understand this stress sensing and response mechanism, we will utilize our original mouse model and cutting-edge omics imaging technology. We aim to elucidate the novel mechanism of gastric disease through the gastro-brain interaction and contribute to new prevention and treatment strategies.

Neural substrate of muti-sensory integration and separation

FUNAMIZU Akihiro
Lecturer,
The University of Tokyo

To estimate the external world from multi-sensory inputs, humans and animals are not simply required to integrate all the sensory inputs. Instead, they are required to predict and integrate a series of inputs coming from a same source, while separate them from other sources. The aim of our study is to investigate the neural mechanism of determining the multi-sensory integration and separation by combining methods of psychology, biology, and computations. Our future goal is to develop an AI to perceive the external world like our brain.

Regulation of sensory integration and developmental disorders by synaptic pruning

MARUOKA Masahiro
Program-Specific Lecturer,
Institute for Advanced Study, Kyoto University

Neural circuits mature through "synaptic pruning", which removes unnecessary synapses after excessive synapse formation in the early phase of brain development. During this process, the neural circuits are modified to integrate the individual senses in response to the various stimuli received by the sensory modalities. Failure of this process leads to developmental disorders. In this study, I will establish a mouse model of developmental disorders caused by the defect of synaptic pruning and elucidate the mechanism of sensory integration through analysis of this mouse model.

PRIME Started in 2023 ··· 3rd period

Elucidation of brain system to integrate multi-modal sensory information constructing episodic memory

OHKAWA Noriaki
Associate Professor,
Dokkyo Medical University

Episodic memory is encoded in our brain like a photograph or a diary. During a novel experience, various contextual information composed of multiple sensory information are integrated into one episodic memory. However, it remains unclear how individual memory including various sensory information is encoded in our brain. In this research, by applying our unique technique for multi-channel electrocorticogram recording for mouse, we propose to identify characteristics of large-scale cortical waves expressed across multiple sensory areas at timing when engram cells of the hippocampus are representing memory information. Through this research, we elucidate large-scale brain system to integrate multiple sensory information for encoding and consolidation of one episodic memory.

Functional analysis of hippocampal dCA1 neurons underlying odor information processing.

SAKAMOTO Masayuki
Associate Professor,
Graduate School of Biostudies, Kyoto University

Many living animals, including humans, make various behavioral choices based on odors, such as recognizing food, sensing danger, and identifying mating partners. However, it is not well understood how olfactory information processed in the olfactory bulb is represented in higher brain regions. In this study, I will develop an innovative high-precision measurement technology that allows for the visualization and manipulation of the sensory system, and will elucidate the function of dorsal hippocampal neurons in olfactory information processing.

Therapeutic targeting of macrophage thermosensor in inflammatory diseases

TAKEDA Norihiko
Professor,
The University of Tokyo Hospital

The occurrences or symptom of inflammatory diseases or cardiovascular disorders are strongly influenced by external environment; thus, those disorders are termed as living environment-related diseases. Among them, some of the bacterial and viral infection develops more frequently in winter season. While cold environment is estimated to suppress immune response and inflammatory reaction, the molecular link between cold temperatures and immune system are largely unknown. In this study, we will focus on the effects of cold environments on macrophage activation to explore novel therapeutic approaches to living environment-related diseases.

Elucidation of a novel visceral pain-sensing mechanism and development of therapeutic methods

TANAKA Tatsuhide
Lecturer,
Nara Medical University

Irritable bowel syndrome (IBS) is a functional disorder of the gastrointestinal tract caused by mental stress or autonomic nervous system dysfunction, resulting in abnormal bowel movements and abdominal pain. In this study, we will clarify how the primary afferent nerves distributed in the distal colon receive pain information from the aspect of neuroimmune crosstalk. We hope to develop novel analgesics as molecular targeted therapies for visceral pain in the future.

Defecation mechanism via rectal sensation through the brain defecation center

TANAKA Yoshimasa
Assistant Professor,
Kyushu University Hospital, Hepatology & Pancreatology

Chronic constipation has received increasing attention in recent years because it is a risk factor for cardiovascular and cerebrovascular disease and has a negative impact on life expectancy. One of the causes of constipation is a decrease in rectal sensation, but the mechanism is not fully understood. In this study, we aim to elucidate the mechanism of defecation by rectal sensation through both basic research focusing on the relationship between rectal sensation - brain defecation center - anorectal motility, and clinical research using anorectal function tests in patients with chronic constipation.

Gut sensing system with mesenchymal cells-enteric nervous -central nervous system interaction

TAMADA Hiromi
Assistant Professor,
Graduate School of Medical Sciences, University of Fukui

"Gut-Brain Axis" is one of the current topics in health and medical care fields. In this study, to understand the whole sensing mechanism in the gut, the complicated and unique interactions among mesenchymal cells, the enteric nervous system and the central nervous system are explored from the aspects of morphology and physiology. The novel sensory circuit leads to comprehension of very complex and varied GI sensory mechanisms and functions reflecting them.

Elucidating the human circadian rhythm sensing network using master clock organoids and exploring chronotherapeutic drugs for personalized medicine

TAMIYA Hiroyuki
Assistant Professor,
Institute of Biomedical Science, Kansai Medical University

Our circadian clock is regulateed by the suprachiasmatic nucleus (SCN), the brain's master clock, which integrates multiple inputs including light and other stimuli to define our internal body time. However, it is still largely unknown how the multiple senses are integrated. I've recently succeeded in generating SCN from ES/iPS cells in vitro. In this research, we aim to reproduce the circadian sensing network expanding our SCN organoid system and shed light on the time-information integration mechanism. This work holds promise for creating chronotherapeutic drugs personalized to individual circadian needs.

Development of Innovative Treatment for Intractable Visual Impairment Using Innate Immune Memory to Restore Neuro-Immune Network Alterations and Disrupted Light Sensing Mechanisms

HATA Masayuki
Associate Professor,
Kyoto University

Age-related macular degeneration (AMD), one of the leading causes of blindness in the world, is an intractable retinal disease whose basic pathogenesis is neuroinflammation and pathological angiogenesis caused by innate immune responses. We have shown that past obesity and infection form epigenetic memories in innate immune cells, which accumulate with age, leading to the onset and progression of AMD. In this project, we aim to elucidate the regulatory mechanism of the neuro-immune network by innate immune memory and link it to therapeutic applications.

Elucidating the significance and rule of the neural dynamics change between wakefulness and sleep

NOMOTO Masanori
Associate Professor, Graduate School of Medicine and Pharmaceutical Sciences, University of Toyama

As in dreaming, the brain is active not only during wakefulness, but also during sleep. Brain activity during sleep is necessary for memory consolidation and various cognitive functions. However, the mechanism of how the brain processes information on cognitive functions during sleep remains unclear. In this study, we focus on the olfactory pathway, which is not easily affected during sleep, and use an optogenetic pseudo-olfactory stimulation to seamlessly track brain representations and memory information related to smells during wakefulness and sleep. Results of this research will elucidate the dynamics and principle of brain information processing during wakefulness and sleep states.

Study of primate dopamine neural circuit mechanisms underlying impulse control for action selection based on sensory information Professor

MATSUMOTO Masayuki
Professor, Center for the Evolutionary Origins of Human Behavior, Kyoto University

Impulse control is a fundamental ability in our daily life. For example, we can suppress the impulse to reach a destination quickly when we see a trafic red light, and also we can suppress the impulse to obtain a small immediate reward and wait for a large delayed reward. However, this ability is impaired in many psychiatric disorders, which is closely related to the dopamine system. Using macaque monkeys, which are genetically close to humans, this study investiagtes the dopamine circuit mechanism that causes impairments in the ability of impulse control.