

Mechanobiology

Mechanobiology Elucidation of Mechanobiological Mechanisms and Their Application to the Development of Innovative Medical Instruments and Technologies



[Research and Development Objectives]

Elucidation of mechanobiological mechanisms leading to the development of innovative medical instruments and technologies

Program Supervisor (PS)

SOKABE Masahiro

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Program Officer (PO)

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In this R&D area, the main objective is to understand the body's systems for sensing, transduction, and response to physical stimuli and to create platform technologies with healthcare applications.

When the cells making up the body are exposed to different physical stimuli, such as skeletal muscle/organ functioning, blood flow, gravity, or signals originating from neighboring cells and substrates, they use these stimuli to self-regulate replication, differentiation, death, morphogenesis, or movement. We do not yet have a detailed understanding of how the cells perceive physical stimuli or how these stimuli elicit physiological or pathological responses after the stimuli have been converted into intracellular signals. Mechanobiology is a new R&D area that combines physics, engineering, medical science, and biology to investigate such questions and clarify the role of physical stimuli in regulating the structure and function of cells, tissues, organs, and the body as a whole.

A better understanding of the mechanisms involved in perception of and response to physical stimuli is expected to open up new avenues of research in the quest to understand currently unresolved issues like how the body develops, grows, and forms tissues; how a failure of these mechanisms leads to disease; or how to develop regenerative medicine techniques for tissues and organs. We also expect to develop devices that can quantitatively apply and control physical stimuli or platform technologies for the precise measurement of biological responses to physical stimuli.

R&D Area Advisors

KOTERA Hidetoshi	Professor Emeritus, Kyoto University
SATO Masaaki	Professor Emeritus, Tohoku University
SHIGEMATSU Takashi	Bio Science & Engineering Laboratory, Research & Development Management Headquarters, FUJIFILM Corporation
TAKEDA Shinichi	Honorary director general, National Institute of Neuroscience, National Center of Neurology and Psychiatry (NCNP)
NARUSE Keiji	Professor, Okayama University
NISHIMOTO Takahiro	General Manager, Technology Research Laboratory, Shimadzu Corporation
MIZUMURA Kazue	Professor Emeritus, Nagoya University



Started in 2015 ••• 1st period

Exploration of molecular mechanisms of nucleo-cytoplasmic mechano-transduction and its medical application

OGURA Toshihiko

Professor, Institute of Development, Aging and Cancer, Tohoku University

Started in 2015 ••• 1st period

Development of mechanobiomaterials for quality keeping culture of stem cells

KIDOAKI Satoru

Professor, Institute for Materials Chemistry and Engineering, Kyushu University

Started in 2015 ••• 1st period

Elucidation of mechano-cascade by osteocyte for bone homeostasis

NAKASHIMA Tomoki

Professor, Department of Cell Signaling, Graduate School of Medical and Dental Sciences, Tokyo Medical and Dental University

Started in 2015 ••• 1st period

Analyses of the mechanism underlying nano-scale mechanoresponses of the inner ear and its application to medical therapies for deafness

HIBINO Hiroshi

Professor, Department of Molecular Physiology, Niigata University School of Medicine

Started in 2015 ••• 1st period

Development of a comprehensive analysis technique for mechanotransduction through tissue-cell-nucleus pathway toward the elucidation of mechanisms of disease development in blood vessels

MATSUMOTO Takeo

Professor, Department of Mechanical Systems Engineering, Graduate School of Engineering, Nagoya University

Started in 2015 ••• 1st period

Vascular mechanobiology: Molecular mechanisms of blood flow sensing and cerebral aneurysm development

YAMAMOTO Kimiko

Associate Professor, Graduate School of Medicine, The University of Tokyo

Started in 2016 ••• 2nd period

Analysis of mechano signal cascade regulating tendon/ligament homeostasis and regeneration

ASAHARA Hiroshi

Professor, Department of Systems Bio Medicine, Graduate School and Faculty of Medicine, Tokyo Medical and Dental University

Started in 2016 ••• 2nd period

Elucidation of membrane and sugar chain environment required for mechano-sensing/response and its application to the development of therapeutic strategy for muscle diseases

KANAGAWA Motoi

Professor, Ehime University Graduate School of Medicine

Started in 2016 ••• 2nd period

Mechanobiology in cancer and stroma cells

HAGA Hisashi

Professor, Faculty of Advanced Life Science, Hokkaido University

Started in 2016 ••• 2nd period

Mitochondrial mechanobiology to unravel its role in muscular atrophy

HIGASHITANI Atsushi

Professor, Tohoku University Graduate School of Life Sciences

Started in 2017 ••• 3rd period

Molecular mechanobiological and pathological analyses of cell migration and neuronal network formation based on the force interaction between cells and adhesive substrates

INAGAKI Naoyuki

Professor, Graduate School of Biological Sciences, Nara Institute of Science and Technology

Started in 2017 ••• 3rd period

Analysis of angiogenesis-related signaling pathways regulated by cyclic compression force-for developing wound treatment devices by non-contact ultrasound-

OGAWA Rei

Professor and Chief, Department of Plastic, Reconstructive and Regenerative Surgery, Graduate School of Medicine, Nippon Medical School

Started in 2017 ••• 3rd period

Development of novel therapeutic approaches for heart failure by dissecting the mechanisms of cardiomyocyte mechanobiology

KOMURO Issei

Professor, Graduate School of Medicine, The University of Tokyo



Started in 2015 ••• 1st period

Thermal control of cellular functions using the technology to create organelle-size heat spots

ARAI Satoshi

Associate Professor, NanoLSI, Kanazawa University

Started in 2015 ••• 1st period

Cardiac reprogramming and heart regeneration via mechanotransduction

IEDA Masaki

Professor and Chair, Department of Cardiology, Faculty of Medicine, University of Tsukuba

Started in 2015 ••• 1st period

Elucidation of the molecular mechanisms and physiological role of mechanotransduction and establishment of innovative targets for medicine

KATANOSAKA Yuki

Lecturer, Graduate School of Medicine, Dentistry and Pharmaceutical Sciences, Okayama University

Started in 2015 ••• 1st period

Mechanobiology of baroreceptor afferent nerves and a development of nerve engineering-based medical therapy

KAMIYA Atsunori

Professor, Department of Cellular Physiology, Graduate School of Medicine, Okama University

Started in 2015 ••• 1st period

Stress intensity-dependent mechano-responses of articular chondrocytes

SAITO Taku

Associate Professor, Orthopaedic Surgery, Graduate School of Medicine, The University of Tokyo

Started in 2015 ●●● 1st period

Nuclear micromechanics and mechano-transduction mechanisms

SHIMAMOTO Yuta
Associate Professor, Center for Frontier Research, National Institute of Genetics

Started in 2015 ●●● 1st period

Elucidation of plasma membrane tension dependent signal transduction in cancer cell invasion and metastasis

TSUJITA Kazuya
Lecturer, Biosignal Research Center, Kobe University

Started in 2015 ●●● 1st period

Development of biomimetic microdevices to recapitulate physiological mechanical stimulation to model hematopoietic function

TORISAWA Yu-suke
Associate Professor, The Hakubi Center for Advanced Research, Kyoto University

Started in 2015 ●●● 1st period

Non-invasive force measurement using fluctuation for organelle transport in neurons

HAYASHI Kumiko
Associate Professor, Graduate School of Engineering, Tohoku University

Started in 2015 ●●● 1st period

Elucidating the mechanisms of mechanotransduction in angiogenesis

FUKUHARA Shigetomo
Professor, Dept. of Mol. Pathophysiol., Inst. of Adv. Med. Sci., Nippon Medical School

Started in 2015 ●●● 1st period

Innovation of novel medical technology against cardiac mechano-sensor, pannexin

FURUKAWA Tetsushi
Professor, Department of Bio-informational Pharmacology, Medical Research Institute, Tokyo Medical and Dental University

Started in 2015 ●●● 1st period

Mechanobiological understanding of the mechanism of selective gene expression regulated by extracellular nano-topographical cues, and the application to external control of the stem cell differentiation

MIYOSHI Hiromi
Associate Professor, Faculty of System Design, Tokyo Metropolitan University

Started in 2015 ●●● 1st period

Study on the autonomous regulation of ciliary motility through mechanical feedback system

YOSHIMURA Kenjiro
Professor, Shibaura Institute of Technology

Started in 2016 ●●● 2nd period

Light-responsive dynamically manipulatable cell culture platforms for revealing the mechanism of cellular mechanostuctural memory

UTO Koichiro
Independent Scientist, MANA, National Institute for Materials Science (NIMS)

Started in 2016 ●●● 2nd period

Identification and functional analysis of mechanosensor proteins involved in actin cytoskeleton remodeling

OHASHI Kazumasa
Professor, Graduate School of Life Sciences, Tohoku University

Started in 2016 ●●● 2nd period

Molecular mechanisms of mechano-feedback from epithelial architecture in organogenesis

KONDO Takefumi
Program-Specific Assistant Professor, Graduate school of Biostudies, Kyoto University

Started in 2016 ●●● 2nd period

Single molecule imaging; on the mechanism behind the tension sensing by actin filaments

TATSUMI Hitoshi
Professor, Kanazawa Institute of Technology

Started in 2016 ●●● 2nd period

Elucidation of mechanobiology of renal glomerular podocytes and development of innovative evaluation method of intraglomerular pressure

NAGASE Miki
Professor, Department of Anatomy, Kyorin University Faculty of Medicine

Started in 2016 ●●● 2nd period

The role of phospholipid flippase-mediated mechanosensing machinery in myotube formation

HARA Yuji
Associate Professor, Graduate School of Engineering, Kyoto University

Started in 2016 ●●● 2nd period

Studies on the mechanism and physiology of brain sensors for osmolality and Na⁺ level

HIYAMA Takeshi
Senior assistant professor, Graduate school of medicine dentistry and pharmaceutical sciences, Okayama University

Started in 2016 ●●● 2nd period

Elucidating the mechanism of cellular force-sensing and -generating systems by using live-cell, low invasive imaging technique

YOSHIMURA Shige H.
Associate Professor, Division of Integrated Life Science, Graduate School of Biostudies, Kyoto University

Started in 2017 ●●● 3rd period

Imaging and optical control of force-field in cardiomyocyte using DNA nano-bio device

IWAKI Mitsuhiro
Deputy Team Leader, Center for Biosystems Dynamics Research,RIKEN

Started in 2017 ●●● 3rd period

Mechanobiology of stem cell tissues under adhesion-modulated microenvironment

OKEYO Kennedy Omondi
Senior Lecturer, Institute for Frontier Life and Medical Sciences, Kyoto University

Started in 2017 ●●● 3rd period

Isolation of novel temperature-sensing proteins and development of applied-technology using these molecules

KUHARA Atsushi
Professor, Department of Biology, Faculty of Science and Engineering, Konan University

Started in 2017 ●●● 3rd period

Quantification of stress/deformation/signal fields and data assimilation to understand and predict mechanics of a growing epithelial tissue

SUGIMURA Kaoru
Associate Professor, Department of Biological Sciences, Graduate School of Science, The University of Tokyo

Started in 2017 ●●● 3rd period

Elucidation of invasion mechanism of glioma stem cell-derived population response induced by interstitial flow

SUDO Ryo
Professor Department of System Design Engineering, Keio University

Started in 2017 ●●● 3rd period

Identifying and manipulating molecules responsible for insufficient transcriptional activation of HSF1 and mitochondrial adaptabilities in aged skeletal muscle

TAMURA Yuki
Assistant Professor, Department of Physical Education, Faculty of Sport Science, Nippon Sport Science University

Started in 2017 ●●● 3rd period

The function and regulation of mechanosensors in skin metabolism

TOYOSHIMA Fumiko
Professor, Institute for Frontier Life and Medical Science, Kyoto University

Started in 2017 ●●● 3rd period

Functional analysis of a transcriptional co-activator that senses mechanical stimulation and promotes tissue fibrosis for developing a new fibrotic treatment method

NAKAYA Michio
Associate Professor, Graduate School of Pharmaceutical Sciences, Kyushu University

Started in 2017 ●●● 3rd period

Elucidation of the role of mechanosensation for proper circulation of lymph

NONOMURA Keiko
Assistant Professor, Division of Embryology, National Institute Basic Biology