April 15, 2024

Tell Us More About Moonshot Goal #7, PD HIRANO!

Japan Agency for Medical Research and Development (AMED)
Moonshot Research and Development Program

Introduction

Hi, I'm Hirano.
I will introduce Moonshot Goal #7
by answering questions!

HIRANO Toshio, Ph.D.

Goal #7 Moonshot Program Director (PD)

Professor Emeritus, Osaka University /
President, Osaka International Cancer Treatment Foundation

【Specialized field】
immunology and life science

Discovered Interleukin 6 and opened new ways to treat autoimmune diseases. Draws on deep and wide-ranging knowledge and experience, from work promoting cutting edge multidisciplinary research to basic medical research to medical applications; served as head of Osaka University and of QST.

I. About Research & Development Program

What is Moonshot Goal #7?
What will be done?

There is ambitious goal : Realization of sustainable care systems for enjoying one's until 100 years old. We set three targets to attain the goal.

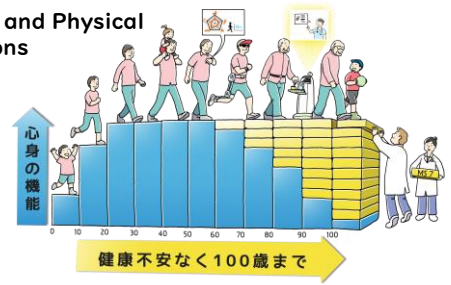
PD HIRANO Toshio

Goal #7

【 Moonshot Goal #7 】

Realization of sustainable care systems to overcome major diseases by 2040, for enjoying one's life with relief and release from health concerns until 100 years old.

【Targets of Moonshot Goal】



To Age 100 without Health Concerns

1. Realization of a society where everyone can prevent diseases spontaneously in daily life

- Develop technologies to monitor all living body trends with lower physical and mental load by 2030.
- Establish infrastructure to maintain good mental and physical health by developing technologies, in order to stay healthy and prevent the onset and aggravation of diseases by regulation of immune systems or sleep, etc., and to visualize individual physical and mental state in daily life and urge people to voluntarily take healthy maintenance actions most suitable for them by 2040.

2. Realization of medical networks accessible for anyone from anywhere in the world

- Establish a technology platform to provide quality medical and nursing care suitable for each individual appropriately even with less providers by developing compact, speedy and high-sensitivity diagnostic and treatment devices as well as technologies to further enhance doctors' medical opinion and diagnostic capability by 2030.
- Establish a medical network to provide the same level of medical care as a normal time regardless of region and even upon disasters and emergencies by developing diagnostic and treatment devices for simple tests and treatments at home, etc. and diagnosis- and treatment-free technologies for part of chronic diseases by 2040. In addition, develop methods for radical treatment and precision medicine for diseases such as cancer and dementia by substantially reducing the development period of drugs and medical devices, etc. through establishment of data science and evaluation systems by 2040.

3. Realization of drastic improvement of QoL without feeling load (realization of an inclusive society without health disparity)

- Develop technologies to improve body function through load-reducing rehabilitation and support self-reliant life at home and to improve ailing living biocontrol systems by 2030.
- Establish a social infrastructure to enable self-reliant life at home without depending on nursing care by developing such technologies as the recovery of body function with rehabilitation without feeling load, normalization of ailing biocontrol systems, regeneration or substitution of weakened organs and so forth by 2040.

Ⅰ. About Research & Development Program

What kind of society do you envision in 2040?

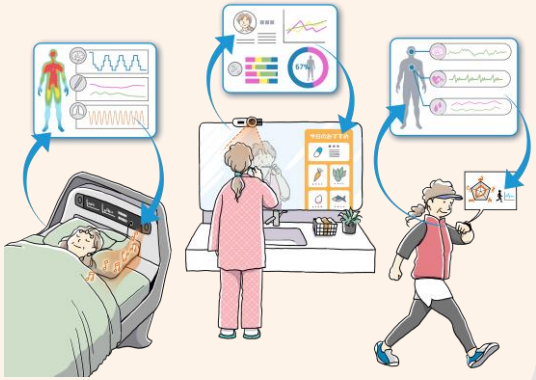
From the three targets, we believe that we can achieve the following vision of society.

HIRANO Toshio PD

Goal #7

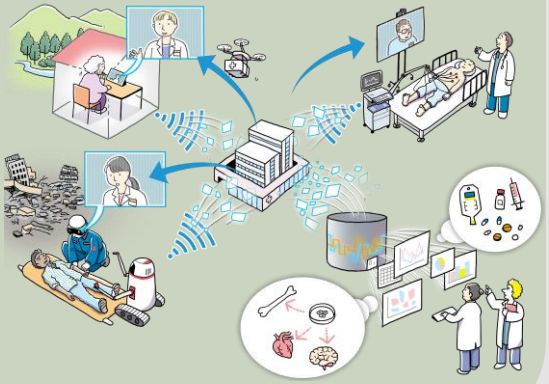
First,

Each and every one can live a healthy life of one's own accord, predicting the future health conditions, and at the same time, mechanisms to lead to health are embedded in every line of daily life.



Second,

Regardless of the skill levels and number of medical and nursing caregivers, secure and quality medical and nursing care can be provided and accessed no matter where one lives and even upon disaster or emergencies.



Third,

Even when faced with various changes in life stage with ailing mind and body function, each and every person can be empowered by technologies and social infrastructure without falling ill, and then their capabilities are unlocked.

Ⅰ. About Research & Development Program

What is the key for Moonshot Goal #7?

"Controlling the chronic inflammation" is the keyword.

HIRANO Toshio PD

Goal #7

1. Chronic inflammation is a persistent inflammatory response that deviates from control and is a major cause of age-related diseases.
2. If chronic inflammation can be controlled, disease itself can be dramatically reduced and healthy lifespan can be extended.
3. There are several approaches to control chronic inflammation, such as gut bacteria and immunity, but first we will begin research and approaches with five projects(sleeping, mitochondria, microinflammation, senescent cells, and reprogramming)

Control of **Microinflammation**

MURAKAMI PM

Control of **Sleep/Wake**

YANAGISAWA PM

Control of **Mitochondria**

ABE PM

Microbiome regulation

HONDA PM

Control of Chronic Inflammation

Basis for Realization of a Healthy and long-lived society

Control of **Lysosome and Senescent cells**

NAKANISHI PM

Control of **Inflammation anywhere**

NANGAKU PM

Japan-U.S. cancer collaboration

Reprogramming

FS KURITA PM

【Ended in November 2023】

Prevention of Carcinogenesis Cancer Immunoregulation

NISHIKAWA PM

Normalization of cancer cells

FS KOSEKI PM

FS Feasibility Study

Project 1

Mitochondrial Medicine

MOONSHOT RESEARCH & DEVELOPMENT PROGRAM

ABE Takaaki PM

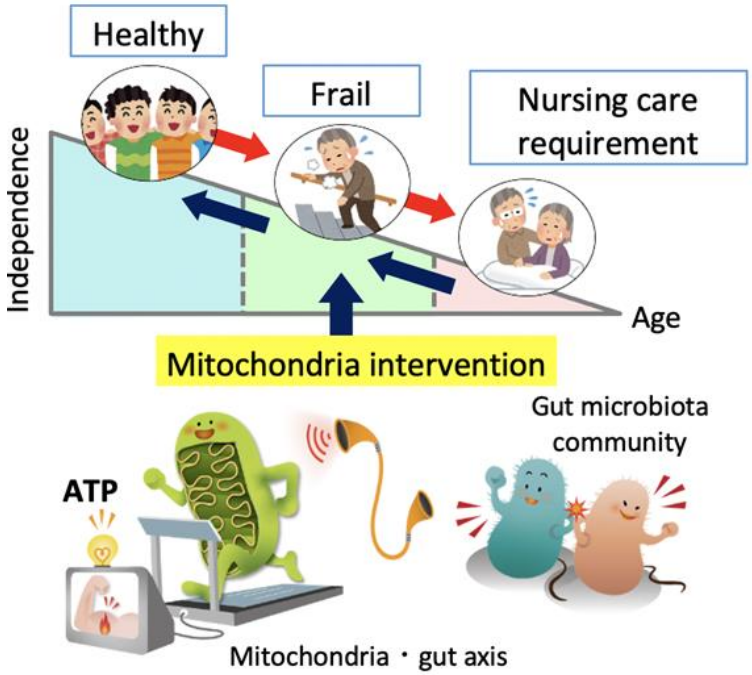
Tohoku University
Graduate School of Biomedical Engineering, Professor

What is your research about?

To elucidate the regulatory mechanisms through a comprehensive and integrated analysis of the "mitochondrial-gut flora relation" in which mitochondria and gut microbiota cooperate to control the health of the host, and to develop non-invasive diagnostic methods and new therapeutic agents.
Through early detection, intervention and treatment of mitochondrial dysfunction, we aim to achieve a society where healthy longevity is achieved by 2040.

What are the goals aimed by 2030?

- To validate new therapeutic agents not only for mitochondrial diseases, but also for many other diseases in which mitochondrial function is impaired as a basis for disease progression, such as hearing loss, sarcopenia, and Parkinson's disease.
- To develop Mitochondrial sensors
- Establish personalized prevention and personalized medicine where rehabilitation, oral care, diet, and medication to prevent frailty are suggested by linking sensor information with biomolecular information database.



How will your research change the medical care in 2040?

By connecting non-invasive sensors such as wearable sensors with the network and analyzing the data, the optimal diet, exercise, and medication for each person will be proposed, thereby achieving a long-lived society where people can live healthy until the age of 100. (prevention)

Effective diagnostic and therapeutic methods will be provided for frailty caused by progressive hearing loss, muscle weakness, cancer, cognitive impairment and depression due to age-related mitochondrial dysfunction. (medical care)

< Main Research Institutes >

Tohoku University, Keio University, RIKEN, Juntendo University, etc. 9 institutes in total

Project 2

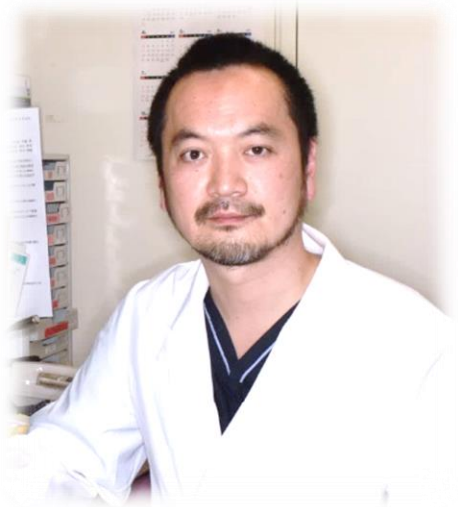
（Ended in November 2023）Development of method for complex tissue regeneration via tissue embryonization

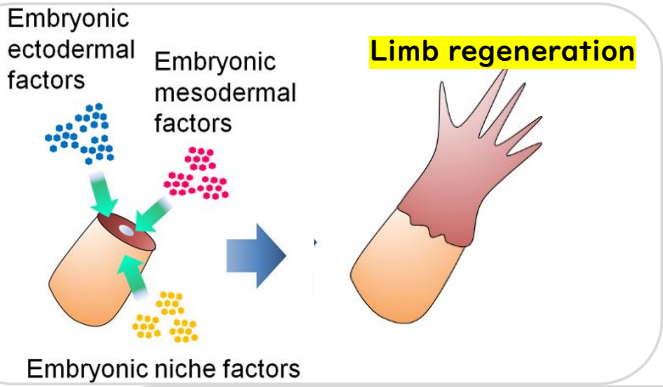
KURITA Masakazu PM

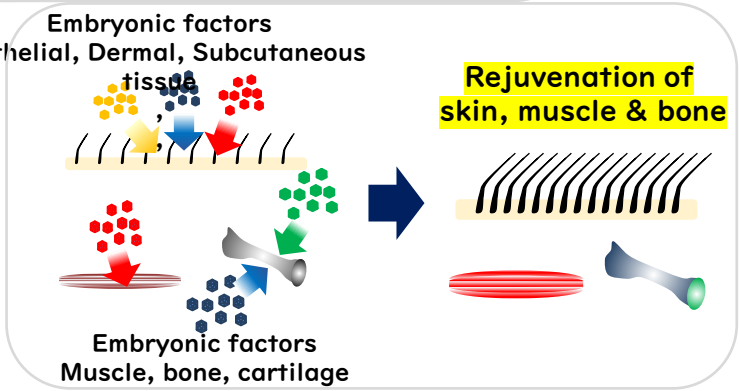
The University of Tokyo Hospital
Department of Plastic Surgery,
Lecturer

What is your research about?

Based on gene transduction into the bodies of mammalian animals, we seek to develop a method for regenerating damaged tissues and organs such as lost limbs and rejuvenation of aging skin, fat, muscle, and bone through tissue embryonization. We aim for clinical application to pave the way towards the reacquisition of irreversibly lost quality of life-associated functions.







What are the goals aimed by 2030?

- Develop the method to regenerate defected limbs through transplantation of fetal animal-derived cells and induced cells / transferring genes to surrounding tissues.
- We develop modified Adeno associated virus vector (AAV: gene carriers) optimized for various soft and hard tissue cells and use them to achieve defect limb regeneration through local gene transfer.

How will your research change the medical care in 2040?

Achieving regeneration of lost limbs in mammals via local tissue embryonization by gene transfer will boost the clinical application of gene therapy for local pathologies.
We will work with industry to develop therapeutic intervention methods using human-derived cells and tissues, leading to the medical application of innovative methods for regenerating lost tissues.

< Main Research Institutes >

The University of Tokyo, Osaka University
2 institutes in total

Project 3 AMED

Extending healthy lifespan by eliminating senescent cells

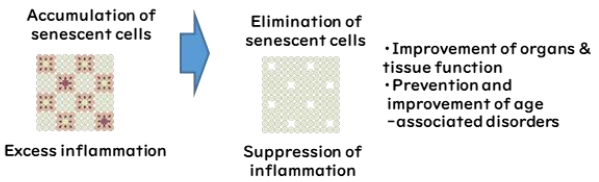
MOONSHOT RESEARCH & DEVELOPMENT PROGRAM

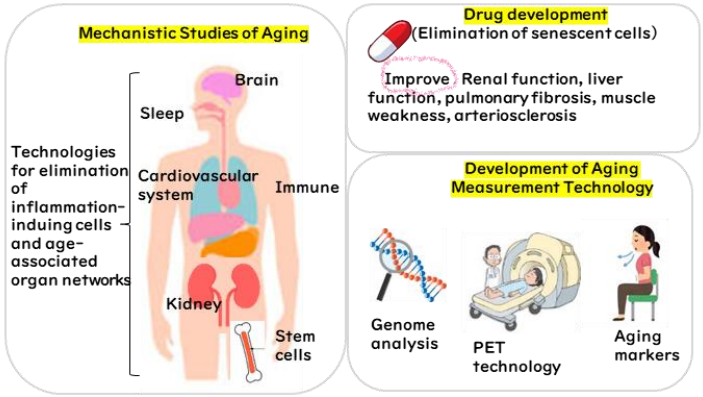
NAKANISHI Makoto PM

The University of Tokyo
Division of Cancer Cell Biology of the Institute of Medical Science,Professor

What is your research about?

This research project aims to develop innovative technologies that eliminate senescent cells (senolysis) which cause tissue microinflammation as a common pathogenesis of aging and age-associated disorders. Thereby, we will establish medical systems for the extension of healthy lifespan through which various age-associated tissue dysfunctions and disorders will be dramatically improved.
In addition, we will also develop technologies that measure senility and establish medical networks that can be easily accessed by everyone and everywhere.





What are the goals aimed by 2030?

- We will conduct clinical trials using the developed technologies for eliminating inflammation-inducing cells in elderly patients with significant organ failure associated with aging, and discover technologies that can be implemented in society.
- Elucidate the nature of inflammation-induced cells in vivo.
- We will implement in society the simple technologies (genome analysis technology, PET technology, and liquid biopsy technology) that can quantitatively measure the progression of aging.

How will your research change the medical care in 2040?

Technology to eliminate inflammation-inducing cells such as senescent cells will be implemented in society as a medical treatment to extend healthy lifespan targeting age-related diseases such as cancer and atherosclerosis, as well as various organ dysfunctions associated with aging.
We will also establish a simple test technology that can measure the degree and speed of aging and build a medical system that can quantitatively measure the adaptations and effects of senescent cell elimination therapy.

< Main Research Institutes >

The University of Tokyo, Keio University, Juntendo University, Kyoto University, etc.　7 institutes in total

Project 4 AMED

Regulating microinflammation: Preventing disease through quantum and neuromodulation technologies

MOONSHOT RESEARCH & DEVELOPMENT PROGRAM

MURAKAMI Masaaki PM

Hokkaido University
Institute for Genetic Medicine,
Professor

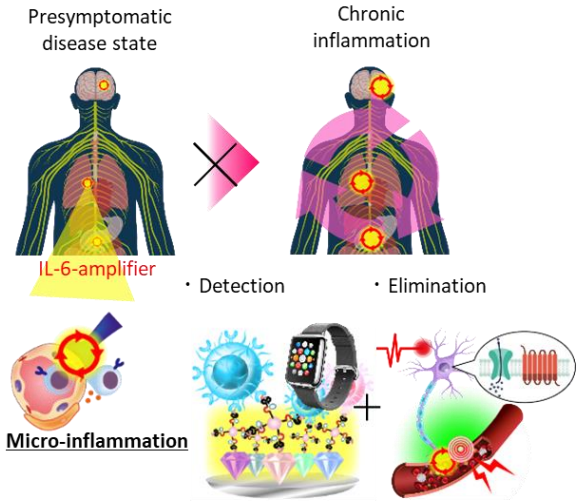
What is your research about?

Tissue-specific disease-related microinflammation develops around blood vessels during presymptomatic disease. Currently, there is no method to detect and eliminate this microinflammation. In this proposal, we aim to establish two novel technologies to reset the presymptomatic disease state to the healthy state: quantum measurements and AI-based information integration analysis. First, we will detect a weak but minimal level of IL-6 amplifier* activation that leads to the development of tissue-specific microinflammation. Then, we will establish neuromodulation technologies** to eliminate the microinflammation via specific neural circuits including gateway reflexes.

What are the goals aimed by 2030?

- To establish an ultra-early and ultra-sensitive method using quantum technology to detect the nature and location in the body of pathogenic cells and factors using bloods or urine.
- To provide preemptive medical treatment to patients with disease utilizing the Neuromodulation technologies and to demonstrate its effectiveness.
- To develop AI technologies that can predict microinflammation formation with high accuracy by having next-generation sensors automatically collect big data obtained through research and development.

*IL-6 amplifier: A mechanism in nonimmune cells to develop various diseases related to inflammation. It is stimulated by NFkB and STAT3 activation.
**Neuromodulation technologies: Weak electrical or magnetic stimulations on specific neural circuits that improve disease symptoms by eliminating microinflammation.



How will your research change the medical care in 2040?

We will develop microinflammation detection technologies based on immune response profiling and big data analysis of physiological and behavioral information, and microinflammation removal technologies such as neuromodulation methods.
These technologies will be implemented in society as ultra-smart medical care that can automatically eliminate micro-inflammation from whole body organs in daily life anywhere in the world by using wearable small AI-controlled devices and ultra-fast transmission and reception from/to big data.

< Main Research Institutes >

Hokkaido University, Niigata University, The University of Tokyo, Nagoya University, etc. 13 institutes in total

Deciphering and Engineering Sleep and Hibernation -- The Future of Medical Care

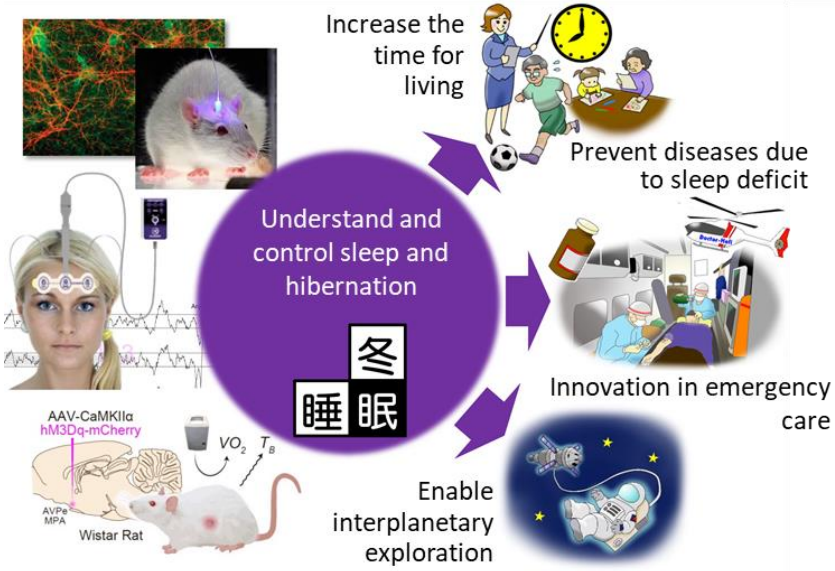
YANAGISAWA Masashi PM
University of Tsukuba
International Institute for Integrative Sleep Medicine, Professor

What is your research about?

Through elucidating the neurophysiological roles and regulatory mechanisms for two immobile modes of animal behavior, sleep and hibernation, we will develop technologies to control sleep and induce hibernation in humans, transforming the future medicine. Induced hibernation will be a step forward to space expedition, a dream of humankind.

What are the goals aimed by 2030?

- To develop fundamental technologies to regulate the sleep time needed by the brain and to control REM sleep.
- To start development of a deep learning model that analyzes sleep big data of 1 million individuals to predict the risk of disease which increases by sleep deficit.
- To develop lead compounds that will be the base of new artificial hibernation inducing drugs, or hibernation induction technologies which will be less invasive on body. In addition, we will develop basic technology to induce artificial hibernation in macaque monkeys.



How will your research change the medical care in 2040?

We will prevent the onset and severity of diseases caused by sleep deficit through the development of technology to adjust amount of the sleep and REM sleep rate required by the brain, and through the deep learning models' development to predict disease risk by analyzing sleep big data.
We also promote development and application of synthetic hibernation technologies and realize to slow the progression of disability in patients with fatal diseases and catastrophic trauma and aim to reduce mortality and aftereffect dramatically.

< Main Research Institutes >

University of Tsukuba, RIKEN, Keio University, S'UIMIN, etc.
7 institutes in total

Project 6 AMED

Bring hospital into home toward controlling inflammation at home

MOONSHOT RESEARCH & DEVELOPMENT PROGRAM

NANGAKU Masaomi PM

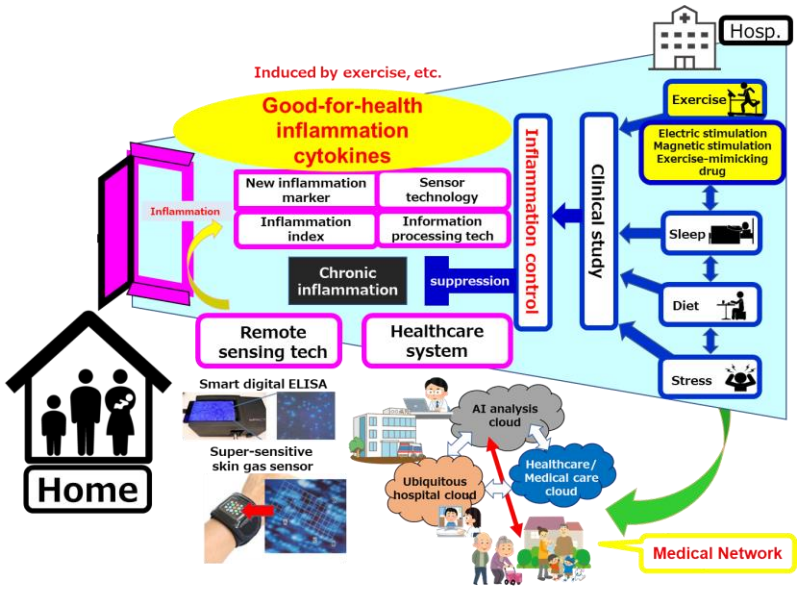
The University of Tokyo Hospital, Department of Nephrology and Endocrinology, Professor

What is your research about?

We will establish technologies analyzing gases emitted from human skin to monitor health condition and then research and develop technologies (exercise-substituting therapy and exercise-mimicking drug) to reproduce “good-for-health inflammation” induced by exercise, etc. By building a medical network that connects wearable sensors and hospitals to enable home diagnosis, we aim to realize a healthy longevity society.

What are the goals aimed by 2030?

- We will build a system that can monitor inflammation biomarkers and conduct clinical research in combination with solutions related to exercise, sleep, and diet.
- We will create an "on-site digital bioanalyzer" that can measure factors related to lifestyle-related diseases, such as inflammation markers, in the comfort of the home.
- We will formulate a clinical trial strategy using controlled inflammation medical technology to induce "controlled inflammation," and build a medical network integrating the solutions obtained.



Toward realization of innovative telemedicine accessible anywhere

How will your research change the medical care in 2040?

We will characterize the state of inflammation for each individual with an "inflammation index" using digital bioassay technology for remote, low-cost, non-invasive assessment, ultra-sensitive body gas sensing, and other technologies. Through control methods of inflammation using electrical and magnetic stimulation devices and exercise-mimetic drugs, we will achieve a society where innovative telemedicine for chronic diseases is "accessible to anyone, anywhere".

< Main Research Institutes >

The University of Tokyo, Nippon Medical School, Kanagawa University of Human Service, etc. 6 institutes in total

Project 7 AMED

Understanding and harnessing the role of the gut microbiome in healthy longevity

MOONSHOT RESEARCH & DEVELOPMENT PROGRAM

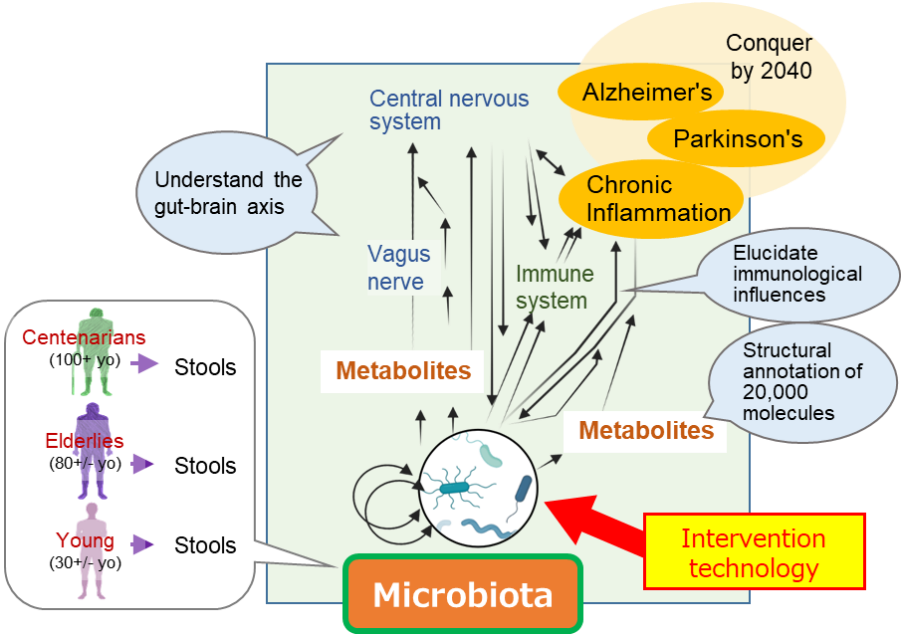
HONDA Kenya PM Keio University School of Medicine, Professor

What is your research about?

We will illuminate the structure of metabolites produced by intestinal microbiota, which are currently poorly defined, and understand their operating principles as well as their effects on the nervous and immune systems.
Through these studies, we aim to conquer Alzheimer's disease, Parkinson's disease, and chronic inflammation, realizing the unprecedented prevention and treatment methods.

What are the goals aimed by 2030?

- We will elucidate the structure and function of 20,000 metabolites derived from intestinal bacteria.
- We will identify intestinal bacterial strains and their responsible molecules that lead to an increase in healthy life span.
- We will elucidate the mechanism of the gut-brain interface and explore its application.
- We will identify intestinal bacteria and their responsible molecules that lead to the control of chronic inflammation and develop intervention methods.



How will your research change the medical care in 2040?

Routine analysis of metabolites derived from intestinal bacteria provides a mechanism for easy health management and understanding of pathological conditions wherever you are.
We offer new therapies to fundamentally prevent and treat chronic inflammation and intractable neurological diseases such as cognitive dysfunction and Parkinson's disease.
We control chronic inflammation and neurological diseases, maintain cognitive and motor functions, and extend healthy longevity through medical intervention of intestinal bacteria such as strain cocktails, dietary modification, endolysin, and IgA therapy.

< Main Research Institutes >

Keio University, RIKEN, Osaka University, CIEA, Tohoku University, etc. 7 institutes in total

Project 8 AMED

A world of zero cancer risk created by rejuvenation using cell lineage conversion

MOONSHOT

KOSEKI Haruhiko PM

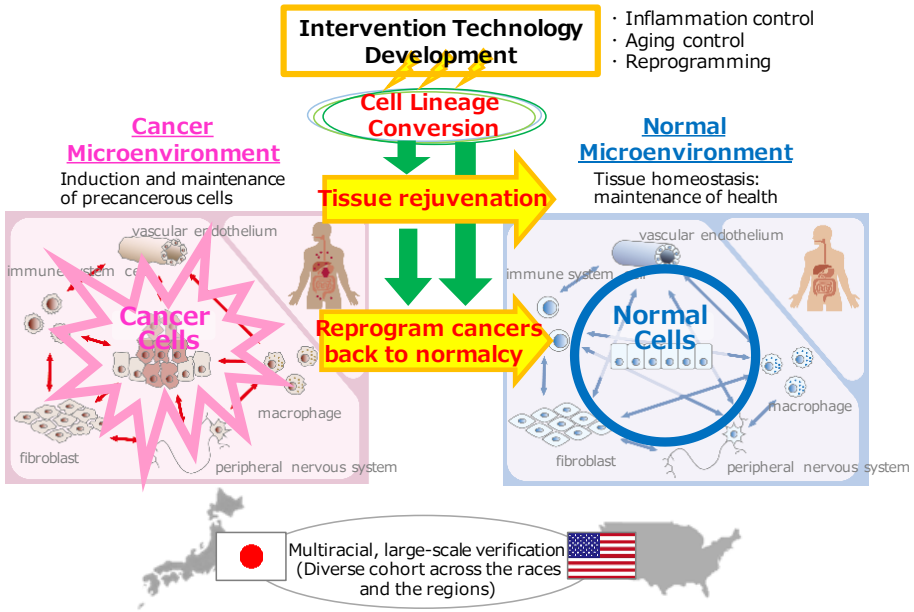
RIKEN,
Center for Integrative Medical Science,
Deputy Director

What is your research about?

Chronic inflammation, which causes aging and cancer, can be a "double-edged sword" because it has the potential to cause "cell lineage conversion" such as cell rejuvenation.
By applying the mechanism of the reprograming in the cells of regenerative medicine,
We will develop a technology to "reverse cancer tissues to normal tissues" via cell lineage conversion. Our interdisciplinary approach involves a multi-racial, large-scale clinical studies based on the Japan/US cooperation.

What are the goals aimed by 2030?

- We will elucidate the mechanisms by which cellular senescence-associated secretion phenomenon (SASP) and chronic inflammation induce the capacity for cellular fate transformation.
- We will elucidate how cell fate transformation by in vivo reprogramming transitions the cellular networks that comprise cancer tissues.



How will your research change the medical care in 2040?

We will develop therapeutic technologies that intervene in the network supporting cancer tissue through cell fate transformation and preventive intervention technologies for precancerous conditions to realize a society with zero cancer risk.
We will globally implement medical and preventive technologies that transcend race, region, and environment through multiracial large-scale validation through Japan-US collaboration.

< Main Research Institutes >

RIKEN, Osaka University, The University of Tokyo, Chiba University, etc.　6 institutes in total

Actualization of a cancer-free society through regulation of chronic inflammation

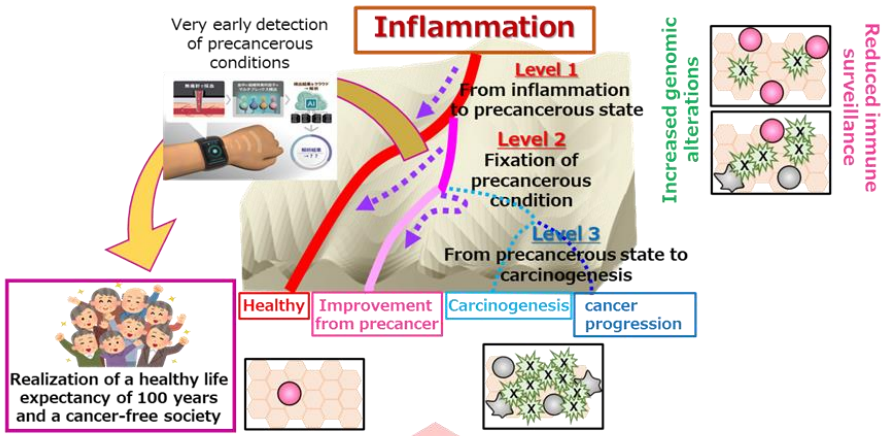
NISHIKAWA Hiroyoshi PM
Nagoya University, Graduate School of Medicine, Professor

What is your research about?

We will elucidate the mechanism of the inflammation-precancerous state-carcinogenesis transition and establish novel technologies to detect cancer-initiating cells at an ultra-early stage based on immune-genomic analysis. We will also work on preventive medicine and new drug discovery / development using wearable devices, etc.
The Japan-U.S. team will strongly pursue this program to realize a "society with zero incidence of cancer"

What are the goals aimed by 2030?

- We will develop a mathematical model to predict the changes of the inflammation-precancerous state-carcinogenesis and build a dynamic prediction model.
- We will develop devices that can identify the origin of inflammation and cancer cells at very early stage with high sensitivity.
- We will develop novel prophylactic and therapeutic methods that target cancer cells in the precancerous state and develop preemptive and ultra-early-stage cancer therapies that can prevent carcinogenesis.



Tight collaboration with the U.S. team

Cancer Immunology : Jedd Wolchok Cancer Genome : Matthew Meyerson
Cancer Epidemiology : Philip Castle
Clinical Trial of Cancer Immunotherapy : James Gulley

How will your research change the medical care in 2040?

We will provide preemptive medicine based on cancer risk (Precision Preemptive Medicine = cancer prevention medicine).
We will provide ultra-early-stage cancer treatment for pathological conditions that have led to irreversible carcinogenesis (establish a new concept for medical treatment after conventional cancer has been detected).
We will realize a system to detect minute changes of inflammation-precancerous state-carcinogenesis at an ultra-early stage.

< Main Research Institutes >

Nagoya University, Aichi Cancer Center, The University of Tokyo, Kyoto University, NCC, etc. 7 institutes in total

2. How to promote Research & Development

How is the program implemented and who are involved?

Goal 7 System Chart

Review the operational structure as necessary.

HIRANO Toshio PD

■Advisors with expertise in cancer, mathematics, engineering, ELSI, etc. will be assigned to the management structure, and management will incorporate the perspective of fusion of different fields.

Advisers

- SAKUMA Ichiro
- SUHARA Tetsuya
- TAKAYASU Misako
- TOKUHISA Takeshi
- MATSUO Makiko
- NAKAGAMA Hitoshi
- MIYAZONO Kohei

■Establish a cooperative system to receive advice from an international perspective as necessary.

MS Evalutaion Committee
[External Experts]

・Preliminary evaluation of PM at the time of adoption
・Mid-term and Ex-post evaluation of PM

■An external evaluation committee was established, and experts with a variety of knowledge composes the evaluation committee. In addition to the mid-term evaluation in the third year and the ex-post evaluation in the fifth year, external evaluations will be conducted whenever deemed necessary and incorporate the results into research promotion.

ABE PM

KURITA PM
[Ended in November 2023]

NAKANISHI PM

MURAKAMI PM

YANAGISAWA PM
- Researcher 1
- Researcher 2

NANGAKU PM

HONDA PM

KOSEKI PM

NISHIKAWA PM

2. How to promote Research & Development

How is the program managed?

- We regularly hold joint meetings of PD, advisors, and all PMs to pursue synergy through collaboration among PMs.
- We also monitor the progress of the projects by inspecting R&D sites and attending the individual project meetings.
- For example,
  Advanced sensors to which quantum science and technology been applied will be utilized in collaboration among multiple projects as much as possible, and we pursue maximization
  of results and efficient allocation of funds as Goal #7.

Goal #7 **HIRANO Toshio PD**

What is important in the implementation of research?

There is a lot, but I'd broadly divide them into the following three!

① Collaboration with other MS goals, with other AMED-implemented projects, and with different academic fields

- To utilize management measures for other goals.
- To seek collaboration particularly with Goal #2 in highly sensitive detection of inflammation, acquisition of time-series data on the onset of inflammation, and integrated analysis with biological information.
- To create synergistic effects by collaborating with related researches in and out of Japan including projects conducted within AMED.
- To consider integrating different fields such as mathematical sciences and humanities and social sciences. And to address R&D in a cross-project manner.

② Effort for Social implementation through co-creation activities

- To introduce the engineering and regulatory science perspectives to bridge the gap from the basic to social implementation and engage in dialogue with industry. Individual projects are also planned considering measures for social implementation and collaboration with companies.
- To take the necessary effort for social implementation by engaging in dialogue and co-creation activities from the early stages of research with the public to discuss the state of society through the implementation of research results and the ethical, legal, and social issues (ELSI) as well as the health economic perspectives.

③ Publicity and Outreach activities

- introduce research content in an easy-to-understand manner, and actively utilize SNS and other means to reach the younger generation.
- To disseminate to the world through symposiums with overseas institutions and enriching the website in English.

Conclusion

It sounds like the Moonshot Goal #7 will change our medical & care system and even our lifestyles better. We are excited with the progress of the researches!

Thank you, Hirano PD, for explaining the details of the program!

It was my pleasure. Thank you for asking questions. In addition to MS Goal #7, Moonshot program targets the following goals from 1～10 in different research areas.

Search for Moonshot online. We offer a lot of information online, so please take a look. Please look forward to our project.

Goal #7 HIRANO Toshio PD

(Reference) Overall view of Moonshot Research and Development

“Moonshot for Human Well-being”

(Moonshot R&D to realize Human well-being)

3 Areas for Goal Setting

- Society: Turning the aging society into the innovative and sustainable society by harnessing diversity through techno-social transformation.
- Environment: Recovery for global environment and growth of civilization
- Economics: Exploring frontiers with science and technology

10 MS Goals to be Achieved

- Goal #1: Overcoming limitations of body, brain, space and time
- Goal #2: Ultra-early disease prediction and intervention
- Goal #3: Coevolution of AI and robots
- Goal #4: Cool Earth & Clean Earth
- Goal #5: Sustainable food supply and consumption
- Goal #6: Fault-tolerant universal quantum computer
- **Goal #7: To Age 100 without Health Concerns**
- Goal #8: Controlling and modifying the weather
- Goal #9: Increasing peace of mind and vitality
- Goal #10: Fusion energy

↑ AMED promote Goal #7