Osaka University Premium Research Institute for Human Metaverse Medicine (PRIMe)

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Conquering all diseases is an ambitious goal that has persisted throughout human history. To achieve this goal, we will establish a WPI center that will create a completely new scientific field, Human Metaverse Medicine, which integrates organoid-based biomedical science with information and mathematical sciences for the first time to comprehensively and continuously understand the processes leading to disease onset that occurs in each individual human body.

Organoid: a miniature three-dimensional tissue that mimics an organ of human or others
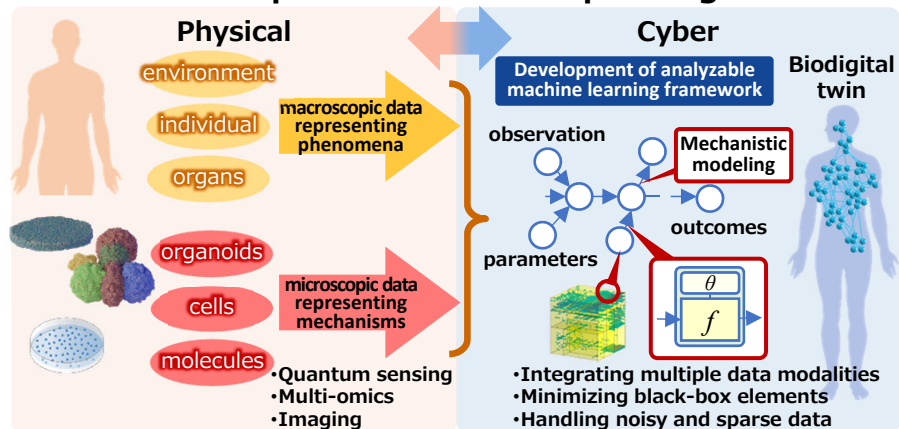
Mission

Many of unsolved diseases are caused by complex interactions between genetic and environmental factors. "**How do such complex interactions cause diseases in human body?**" is the key question in biology.

PRIMe will solve this question **by developing digital twins of human (biodigital twins)** that reproduce in cyber space the biological phenomena and pathological processes in human organs **to create Human Metaverse Medicine**.

Digital twin: a computer reproduction of real-world object using various data collected from reality
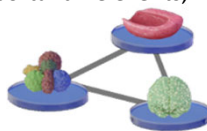
Research

1. Creation of platform to develop biodigital twin

Physical
- environment
- individual
- organs

macroscopic data representing phenomena

- organoids
- cells
- molecules

microscopic data representing mechanisms

- ·Quantum sensing
- ·Multi-omics
- ·Imaging

Cyber

Development of analyzable machine learning framework

Biodigital twin

- observation
- Mechanistic modeling
- outcomes
- parameters

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- ·Integrating multiple data modalities
- ·Minimizing black-box elements
- ·Handling noisy and sparse data

2. Creation of Human Metaverse Medicine

PRIMe will elucidate pathogenic mechanisms in human focusing on important life events, i.e., development, reproduction, and aging.

- ■ Elucidation of cause and pathology of 9 diseases associated with eye, liver, brain, heart, and reproductive organs
- ■ Elucidation of metabolic mechanisms through inter-organ network

3. ELSI study in creation of Human Metaverse Medicine

PRIMe will conduct research and find solutions for ethical, legal, and social issues.

Identities

- ■ World-class researchers of "human organoid-based biomedical sciences" and "information and mathematical sciences" will be united, along with quantum life sciences and ELSI study.
- ■ "Biodigital twin" of human individuals will be developed.
- ■ Using biodigital twins, Human Metaverse Medicine will be created to elucidate pathological mechanisms of human diseases (esp. common diseases), to predict their onset, progression, and treatment response, and to develop their treatment.
- ■ Information space platform "human metaverse" will be constructed to share biodigital twins with researchers and medical professionals world-wide.

- ■ Human Metaverse Medicine will introduce innovation in current medicine to realize ultra-personalized medicine and healthy society.
- ■ Next generation human resources specialized in both biomedical science and information / mathematical sciences will be fostered.

Collaborations

Biodigital twin
NTT Basic Research Laboratories

Organoids
Cincinnati Children's Hospital Medical Center

Data sciences
Curie Institute

Organoids
Stanford University

In silico visualization
RIKEN Center for Advanced Photonics

Mathematical sciences
University College Dublin

Tight linkages around PRIMe

International collaboration