R&D Theme

Development and application of novel imaging, measurement, and manipulation techniques for ultra-early detection of network transformations

Progress until FY2022

1. Outline of the project

To study the early stages of diseases and understand their underlying mechanisms, it is crucial to develop advanced technologies that can accurately capture and analyze changes in interconnected organ networks at a highly precise level. We will analyze synaptic structures involved in neuronal communication, explore the network between the entire body and organs, examine the synthesis and release mechanism of extracellular vesicles implicated in inter-organ communication, and investigate physiological and behavioral changes within the interconnected network. Our goal is to identify a wide range of biomarkers capable of detecting early alterations in inter-organ networks. By measuring and analyzing these inter-organ networks, we aim to discover ultra-early disease markers and develop intervention technologies that can target these networks. This interdisciplinary approach will contribute to advancing our knowledge of neurodegenerative diseases and inter-organ communication.

Fundamental Analysis and Foundational Technology Development Group
(Supervisor:Ohtsuka)

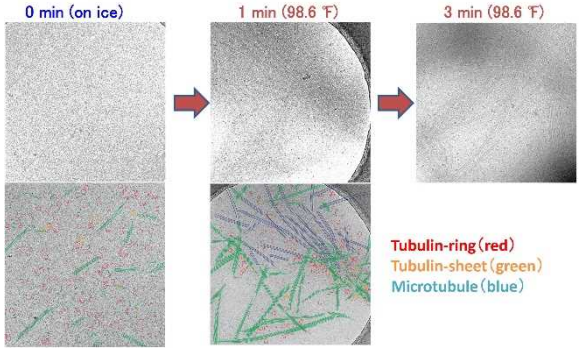
Development Project 4:
Development and Application of Novel Imaging, Measurement, and Manipulation Techniques Enabling Early Detection of Network Remodeling

2. Outcome so far

Nita et al. from Kobe University have presented two notable findings in the field of imaging technology using cryo-electron microscopy techniques.

(1) Time-lapse cryo-microscopic analysis to capture continuous changes in cells at the microscopic level

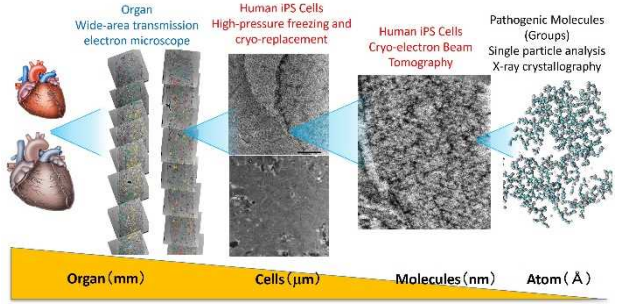
We have developed a new method called time-lapse cryo-microscopic analysis to capture continuous changes inside cells. This technique allows us to observe the process of proteins called tubulin overlapping and forming microtubule structures (*ELife, 2022*). By applying this method to proteins like amyloid beta, tau, and alpha-synuclein, which are implicated in dementia, we can investigate how these proteins come together and create aggregates. In simpler terms, by watching these crucial cellular processes like a video, we hope to uncover insights into the mechanisms underlying dementia.



(2) Cross-scale structural analysis from organs to molecules

Cross-scale cryo-EM analysis

We developed a new method for studying structures at different levels, ranging from organs to tissues, cells, and molecules (*Sci. Adv, 2023*). We initially focused on analyzing the detailed structure of the heart, starting from the entire organ and going down to the tissue, cell, and molecular levels. In the future, we plan to explore the application of this technique to the central nervous system to observe structural changes in its healthy state. The goal is to capture structural alterations occurring in the central nervous system prior to the onset of disease (“Me-byo”).



3. Future plans

We will focus on developing advanced imaging techniques and searching new molecules and biomarkers that can identify “Me-byo”. By collaborating with the AI/Mathematics Group, we aim to establish foundational technologies for ultra-early diagnosis and prevention.