【Grant - in - Aid for Scientific Research on Innovative Areas(Research in a proposed research area)】
Biological Science

Title of Project : Chromosome Orchestration System

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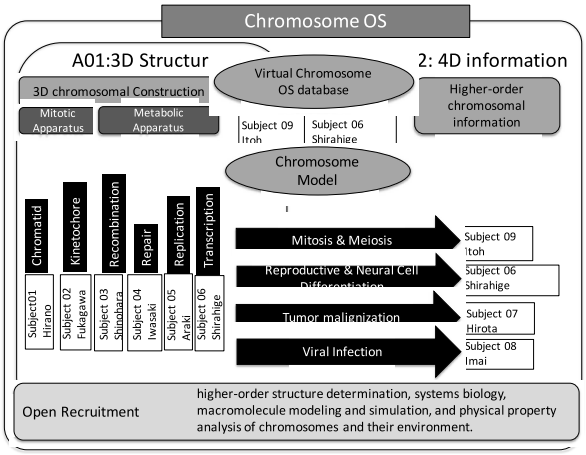
【Purpose of the Research Project】

Chromosomes play a fundamental role in many biological processes. Previous research efforts have advanced our understanding of specific chromosomal events, such as DNA transcription, replication, recombination, partitioning, and epigenetic modification. One of the major future challenges in chromosome biology will be to provide an overall framework of how these individual activities are orchestrated and coordinated to maximize their effects in a variety of biological processes that evolve over time. In this project, we will elucidate the overarching coordinating mechanism that enables a whole set of chromosomes to act as a single functional entity, in both space and time, a new concept that we term “chromosome orchestration system (OS).” For this purpose, we will investigate (i) the mechanisms that determine three-dimensional (3D) chromosome architecture; and (ii) the processes that integrate four-dimensional (4D, i.e., 3D plus time) information transmission. New scientific knowledge gained from this project will further expand the horizon of drug discovery, regenerative medicine, and other life sciences in Japan.

【Content of the Research Project】

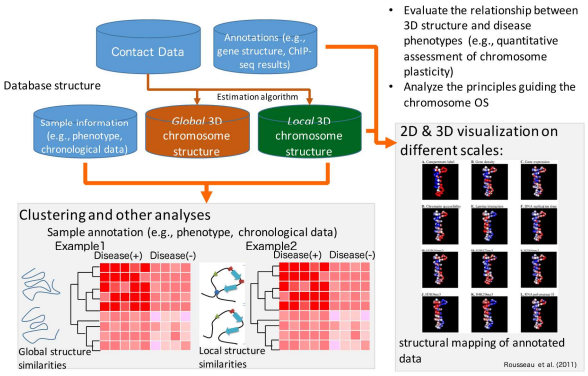
The main goal of this project is to describe the mechanisms that regulate the functional unity of the chromosomes (chromosome OS) by thoroughly examining the structural relationship between, and the hierarchy of, individual chromosomal functions. To this end, this project is composed of two groups of researchers, one focusing on the 3D structure and the other on 4D information processing (Figure 1). In order to develop a complete



understanding of the chromosomal plasticity and functional coordination, the 3D Group will combine molecular devices that mediate individual chromosomal functions and attempt to reconstitute large-scale 3D structures in vitro. The 4D Group, on the other hand, will explore the dynamic, time-dependent processes for 3D chromosomal structure change during the cell cycle, meiosis, differentiation, stress response, and pathogenesis. The Group will further identify the decoding machinery that converts structural alterations into biologically relevant information. While the activities of these two groups will be closely related and mutually complementary for the most part, there will be several topics that are addressed from different perspectives. As a common methodological basis, a chromosome OS information platform and a chromosome model will be developed.

【Expected Research Achievements and Scientific Significance】

We will create the chromosome OS information platform in this project, a knowledge-based



systematic annotation and visualization tool for documenting and explaining chromosomal behaviors in dynamic cellular processes(Figure2). This tool will help clarify the molecular basis for chromosomal integrity and will enhance our understanding of the pathogenesis of chromosome-linked diseases. We will also create a computer-based model that simulates multiple chromosomal functions. This model will have the potential for future application to a variety of fields including disease control and animal breeding.

【Key Words】

Metabolic network
Expression of genetic function
Chromosome construction, function, and partitioning

【Term of Project】 FY2015-2019

【Budget Allocation】 1,146,200 Thousand Yen

【Homepage Address and Other Contact Information】

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