

【Grant-in-Aid for Specially Promoted Research】

Biological Sciences



Title of Project : RNA-based Synthetic Life Systems

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Research Project Number: 20H05626 Researcher Number : 20423014

Keyword : Synthetic biology, RNA, Cell regulation, Artificial cell

【Purpose and Background of the Research】

Classical molecular biology assumes genes and proteins are the primary determinants of cell functions, but it is now increasingly recognized that RNA and RNA-protein (RNP) interactions have crucial roles as well (Fig. 1).

In this project, we will investigate how RNA and RNP interactions regulate gene expressions, and design functional RNA and RNP systems (e.g., synthetic circuits and synthetic organelles) to program cellular behavior.

Specifically, (1) we aim to comprehensively understand and reveal RNA/RNP interaction networks that contribute to the regulation of post-transcriptional gene expressions and the formation of RNA/RNP structures; (2) based on the acquired information of RNA/RNP interaction motifs that determine cellular networks, we aim to design synthetic RNA/RNP-based structures that control cell function; (3) we aim to generate synthetic RNA/RNP-based circuits and functional artificial cells for medical applications; and (4) we aim to create RNA-based protocell models to elucidate the origin of life. Through this research, we will provide a new concept, “synthetic life systems”, by generating living systems based on RNA and RNP.

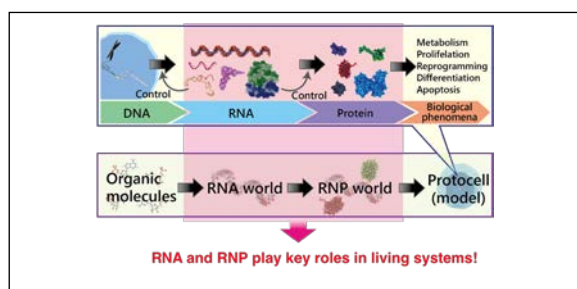


Figure 1 RNA and RNP-based Life Systems

【Research Methods】

In this research, we will utilize our unique RNA and RNP molecular design technology to elucidate unknown biological phenomena consisting of RNA and RNP interactions, and create functional artificial organelles and artificial cells based on that understanding. First, we will elucidate the design principle of RNP networks and RNP organelles by utilizing our unique RNA structure library technology that can extract RNA structural motifs from genome. Furthermore, we will design and construct artificial gene circuits and artificial organelles based on RNA and RNP, and create artificial cell models that will lead to elucidate the evolution of life systems.

【Expected Research Achievements and Scientific Significance】

By elucidating new RNA/RNP networks in cells and engineering them, we will develop innovative technologies that can be widely used in the next generation of science and medical applications. Furthermore, we will develop new methodologies based on the designed RNA/RNP to accelerate the emergence of synthetic living systems.

The overall work of this proposal will require technologies from different fields and will lead to the construction of synthetic RNA and RNP systems and artificial cells that will contribute to the understanding and regulation of living systems.

In the future, RNA-based, synthetic life systems are expected to have a wide range of applications in the medical, healthcare, environmental, and agricultural fields (Fig. 2).

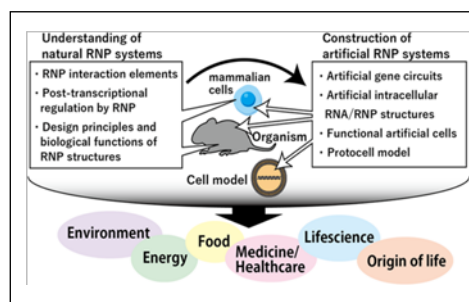


Figure 2 RNA-based Synthetic Systems & Outlook

【Publications Relevant to the Project】

- Endo K, Hayashi K, Saito H: Numerical operations in living cells by programmable RNA devices. *Science Advances*, 5(8):eaax0835, 2019
- Matsuura S, Ono H, Kawasaki S, Kuang Y, Fujita Y, Saito H: Synthetic RNA-based logic computation in mammalian cells. *Nature Communications*, 9:4847, 2018

【Term of Project】 FY2020-2024

【Budget Allocation】 289,100 Thousand Yen

【Homepage Address and Other Contact Information】

https://sites.google.com/view/hirohidesaitolabjp/home_en