

【Grant-in-Aid for Transformative Research Areas (A)】

Manipulating Genomes of Intracellular Symbiotic Organelles: Advancements in Technology, Applications for Fundamental Sciences, and Beyond. (Cytoplasmic Genome Regulation)

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	Project Information	Project Number : 24A301 Keywords : Organelle, Cytoplasmic heredity, Endosymbiosis, Genome editing, Genetic modification	Project Period (FY) : 2024-2028

Purpose and Background of the Research

●Outline of the Research

Endosymbiotic bacteria and their derived mitochondria and chloroplasts have their own internal genomes (cytoplasmic genomes). These genomes are involved in fundamental life processes such as respiration, photosynthesis, cell death, and sex determination. However, their inability or difficulty to be modified has hindered their understanding and application. Our team is at the forefront of successful genome editing and gene transfer of plant organelles. By taking advantage of our cutting-edge technologies, our objectives are (1) to develop flexible regulation technologies for cytoplasmic genomes with expanded target organisms, (2) to understand the molecular mechanisms governing cytoplasmic genome behaviors (maintenance/dynamics/expression), and (3) to elucidate critical life processes in which cytoplasmic genomes are pivotal and translate these findings into practical applications. Our overarching research aim is to make a quantum leap in every aspect of "technology, science, and application" in organelle biology.

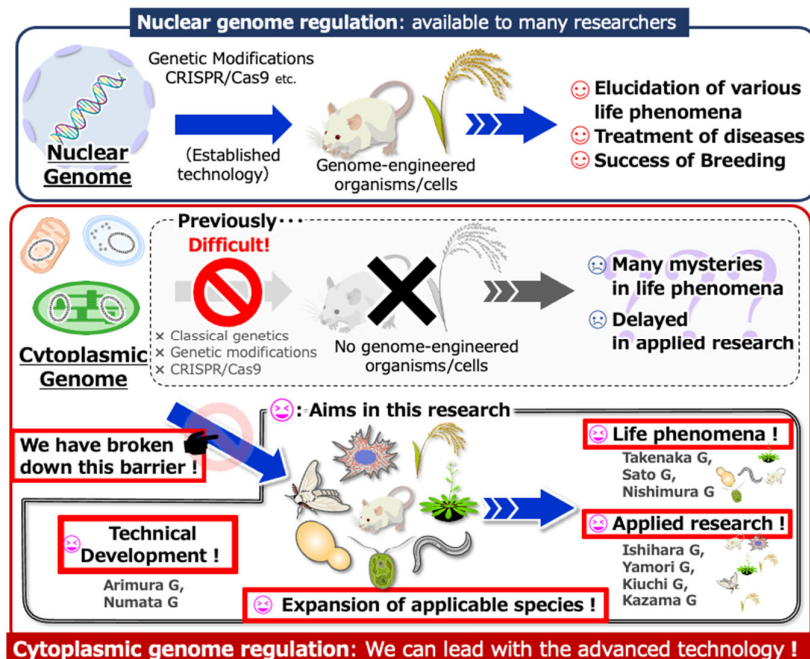


Figure 1. Image about the aim of the "Cytoplasmic Genome Regulation" area.

Objective 1 : Universalization of the cytoplasmic genome regulation technologies

We aim to develop technologies that can be utilized by all researchers working on cytoplasmic genomes, encompassing genome manipulations and ensuring the stable inheritance of foreign genes across successive generations.

Objective 2 : Fully understanding of the genetics of the cytoplasmic genome

We aim to unravel the full picture of cytoplasmic genome genetics using genome regulation technologies, including the population dynamics of multi-copy genomes within cells and individuals, their maintenance and transmission, gene expression and its regulatory mechanisms.

Objective 3 : Understanding of diverse life phenomena affected by cytoplasmic genomes and their development into applied research

We aim to elucidate diverse crucial biological phenomena linked to the cytoplasmic genome, which manifest within host cells and individuals (sex determination, disease symptoms, male sterility etc.) through the application of cytoplasmic genome regulation technologies. Moreover, we use the insights gained to develop medical, industrial, and agricultural seeds that contribute to human society.

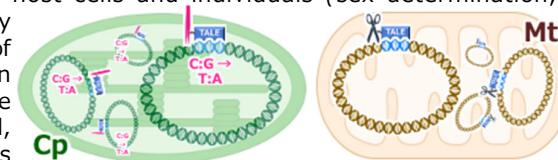


Figure 2. Image of plant organelle genome editing

Expected Research Achievements

●Three subject groups will collaborate to achieve breakthroughs in all the 'technology, science and application' of cytoplasmic genome regulation

The research will be conducted within the research groups of A01 for "Control technology", B01 for "Genetic understanding", and B02 for "Application and development". Continued advancements in cytoplasmic genome regulation technologies will drive progress in B01 and B02, leading to discoveries and applications that benefit society. The benefits and challenges encountered during the implementation of these technologies in B01 and B02, as well as the outcomes, will provide valuable insights for further advancements in A01 "Control technology". This cycle of technology and science feedback will elevate cytoplasmic genome research to a globally recognized "Japan's Specialty of Excellence".

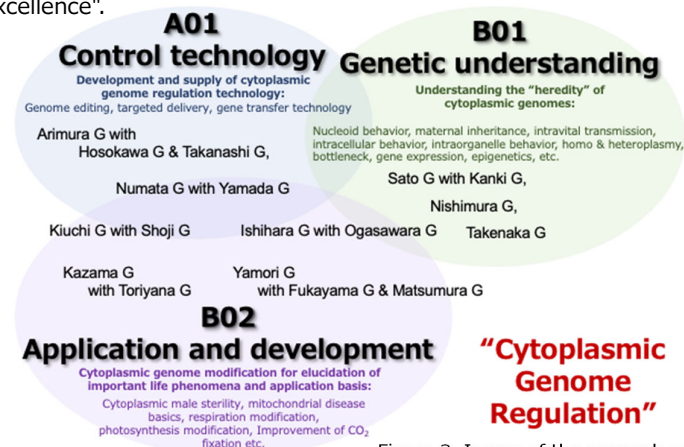


Figure 3. Image of the research group

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<https://www.agr.kyushu-u.ac.jp/cytoplasmicgenomeregulation/>