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

Section III

Title of Project： Remodeling Plant Reproduction System by Cell Fate Manipulations.

MARUYAMA Daisuke
(Yokohama City University, Kihara Institute for Biological Research, Assistant Professor)

Number of Research Area：20B306　Researcher Number：80724111

【Purpose of the Research Project】

Sexually reproducing organisms propagate via the fusion of male and female gametes, a process referred to as fertilization. In contrast to animals, flowering plants are characterized by a complex double fertilization system in which two female gametes (the egg cell and central cell) are simultaneously fertilized by two sperm cells subsequent to pollination. This production of multiple gametes is dependent on the development of haploid tissues termed gametophytes. However, although extensive studies have led to the identification of key factors that contribute to the regulation of male and female gametophyte development in flowering plants, our knowledge regarding the mechanisms underlying gametophyte development and gametogenesis is still comparatively limited. In mammals, the reconstruction of spermatogenesis or oogenesis is recognized as a powerful approach in analyses of the reproductive process, and in this project, we adopt a cell fate manipulation approach for male and female gametophytic cells to examine the nature of the unique gametogenesis system in flowering plants (Fig. 1).

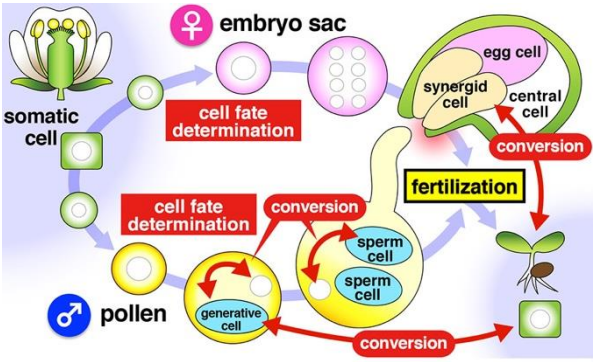

Fig.1 Sexual plant reproduction and our research areas

【Content of the Research Project】

In this research project, participating groups will attempt to manipulate cell fate using different model systems based on their specific adopted approaches. Using *Arabidopsis thaliana* and *Marchantia polymorpha*, the Yamaoka group will strive to steer the conversion of somatic to reproductive cells via the ectopic expression of BNB proteins, which are evolutionarily conserved bHLH transcription factors that regulate the differentiation of male germ cell linages. In contrast, the Mizuta group will examine multiple aspects of cell fate, including the number or timing of mitotic events during sperm cell formation, based on the live imaging of pollen formation following transient gene expression in immature *Nicotiana benthamiana* pollen. Furthermore, the Maruyama group will now attempt to induce embryonic development in the synergid cell through the prevention of programmed cell death and ectopic expression of an embryogenesis-related gene.

【Expected Research Achievements and Scientific Significance】

In this research project, we will perform ectopic expression of selected genes that control gametogenesis and embryogenesis. In contrast to mutant analysis, although ectopic gene expression is a relatively simple approach, it may be sufficiently effective in enabling us to identify the factors that contribute to the induction of gamete transition in somatic or other gametophytic cells. In the past two decades, transcriptome analyses have facilitated the identification of hundreds of gametophyte-specific genes, and excellent *in vitro* culture and transient gene expression systems have been developed for the study of male and female gametophytes, which would provide ideal platforms for the analysis of cell fate transition at the single-cell level. Accordingly, if we are able to gain a sufficiently good understanding of the basic principles of gamete formation, this knowledge could be used to develop novel techniques to produce functional gametes from somatic tissues. This in turn would contribute to the development of innovative approaches in plant breeding, similar to those that have led to advances in the study of mammalian reproduction.

【Key Words】

Gametophyte: Gametophytes are multicellular reproductive tissues generated via a small number of mitotic divisions of haploid meiotic cells. Gametophytes produce gametes from their germ cell linage.

Double fertilization: A unique reproductive system in flowering plants, whereby two sperm cells independently fertilize the egg and central cells to produce an embryo and endosperm, respectively.

【Term of Project】 FY2020-2022

【Budget Allocation】 106,100 Thousand Yen

【Homepage Address and Other Contact Information】

https://www.remod-reprod.com
rprjim@yokohama-cu.ac.jp