Science and Technology Group
Annual Report FY2021

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1 Introduction

After fertilization, one cell embryos undergo repeated cell division to create functional tissues during development in multi-cellular organisms. Although this process is very complicated and mysterious, each division can be classified into two types, symmetric or asymmetric division. Symmetric division produces identical daughter cells for clonal expansion, while asymmetric division increases cell type diversity for differentiation. The balance of symmetric and asymmetric division must be critical for proper development. Early studies in *C. elegans* embryos established a key conceptual framework of asymmetric division, but how symmetric division is actively regulated remains unclear, especially in early embryos.

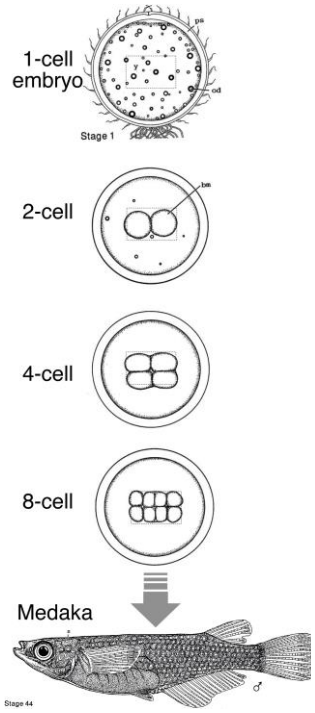

Figure 1. Drawings of embryonic division in Medaka *Oryzias latipes.* (Adopted from Iwamatsu, *Mech Dev.* 2004)

In contrast to *C. elegans*, vertebrate embryos generally show symmetric division in the first several divisions. In Medaka *Oryzias latipes*, one-cell embryos divide symmetrically at least in the first 2 divisions, and generate beautiful symmetrical cellular patterning until the 16-cell stage (Figure 1). During this process, the bipolar spindle must be properly assembled and positioned within a cell since the spindle specifies a cell cleavage site perpendicularly in the middle of the spindle between separating chromosomes during anaphase. However, in contrast to the smaller somatic cells, mechanisms of spindle positioning remain largely unclear in larger vertebrate embryonic cells. Understanding the mechanisms in Medaka embryos must provide useful insights for a better understanding of early embryonic divisions in vertebrates, including human.

2 Activities and Findings

During this fiscal year, I succeeded in establishing several knock-in Medaka strains using CRISPR/Cas9-mediated genome editing (Gutierrez-Triana et al., eLife 2018). Importantly, by crossing two strains, I could visualize both chromosomes and microtubules in live Medaka embryos (Figure 2), which enables me to carefully characterize dynamic behaviors of nuclei, chromosomes and spindles during early embryonic divisions. I also established other knock-in strains which visualize microtubule associate proteins. Unexpectedly, I found that some of these microtubule associate proteins display different localization pattern in early embryos compared to the somatic cultured cells.

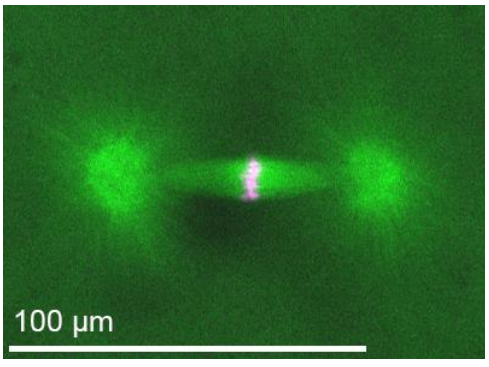

Figure 2. A live cell image of the 2nd mitotic spindle in Medaka. Chromosomes and microtubules are shown in Magenta and Green, respectively.

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3 Collaborations

Kiyomitsu Unit (OIST)
Prof. Minoru Tanaka and Dr. Toshiya Nishimura (Nagoya University)
Dr. Satoshi Ansai (Tohoku University)

4 Publications and other output

<Presentation>
Ai Kiyomitsu, *Mechanisms of early embryonic divisions in Medaka* OIST STG forum, 9 March 2022.

<Grant acquisition>
Takeda foundation Research grant, Representative: Tomomi Kiyomitsu, Collaborator: Ai Kiyomitsu

Uehara foundation Research grant, Representative: Tomomi Kiyomitsu, Collaborator: Ai Kiyomitsu

SHINKA grant, Representative: Tomomi Kiyomitsu, Collaborator: Ai Kiyomitsu, Satoshi Ansai (Tohoku University)