【Grant-in-Aid for Specially Promoted Research】

Biological Sciences

Title of Project : Study of design principle underlying seasonal time measurement and its application

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Research Project Number : 26000013 Researcher Number : 40291413
Research Area : Agricultural sciences
Keyword : Physiology

【Purpose and Background of the Research】

Organisms measure day length to adapt their lives to the seasonal alterations of the earth, and its mechanism is one of the great mysteries in biology today. Although this phenomenon currently attracts tremendous general interest, its mechanism remains unknown in any living organism.

In the previous study, we have uncovered a comprehensive picture of the vertebrate photoperiodic signal transduction pathway (Figure 1). However, it remains unknown just how the biological clock measures day length. Additionally, it is not known how animals adapt to seasonal changes in temperature. In this project, we aim to clarify the design principle underlying seasonal time measurement in vertebrates.

We also aim to design and synthesize transformative bio-molecules that act as substitutes for key molecules to improve animal production and human health by taking full advantage of cutting-edge chemical synthesis expertise.

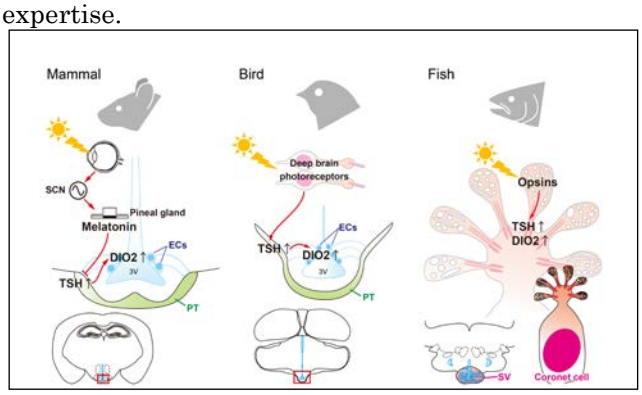

Figure 1. Signal transduction pathway regulating vertebrate seasonal reproduction.

【Research Methods】

Uniqueness of our research lies in the use of various organisms. We will uncover the design principle of seasonal time measurement using mouse, quail, and medaka fish by various methods including transcriptome analysis and genome wide association study. In addition, we will develop transformative bio-molecules by cutting-edge chemical synthesis.

【Expected Research Achievements and Scientific Significance】

Most animals give birth in spring to ensure survival of the offspring, when a moderate climate and abundant food are available. Although seasonal breeding is a clever strategy allowing animals to survive in a changing environment, it is a rate-limiting factor in the aquaculture, poultry, and livestock industries. Thus, understanding of its mechanism is highly relevant to animal production. According to ethical and safety concerns, chemicals that specifically control seasonal reproduction are required. Development of "transformative bio-molecules" represents a powerful strategy and it would cause a paradigm shift in animal production. Seasonal affective disorder and other seasonally related health problems are also reported in human. Thus, this project also has great impact on human reproductive health and mood disorders.

【Publications Relevant to the Project】

・Nakao N, et al., Thyrotrophin in the pars tuberalis triggers photoperiodic response. *Nature* 452, 317-322 (2008)
・Nakane Y, et al., A mammalian neural tissue opsin (Opsin 5) is a deep brain photoreceptor in birds. *Proc Natl Acad Sci USA* 107, 15264-15268 (2010)
・Nakane Y, et al., The saccus vasculosus of fish is a sensor of seasonal changes in day length. *Nature Communications* 4, 2108 (2013)

【Term of Project】 FY2014-2018

【Budget Allocation】 294, 800 Thousand Yen

【Homepage Address and Other Contact Information】

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