【Grant-in-Aid for Scientific Research (S)】

Biological Sciences (Biology)

Title of Project : Contribution of Opsin Properties to Non-Visual Functions

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Research Area : Animal physiology and behavior
Keyword : Animal physiological chemistry, Photobiology

【Purpose and Background of the Research】

Most animals capture light with light-sensitive proteins, opsins and utilize light information for vision and non-visual functions such as light-regulation of biological rhythms. Hence, light-sensing physiologies start with opsin light-absorption; molecular properties of opsin are considered to relate to characteristics of light sensing in cells and organs. Therefore, it is important to understand how much contribution opsin properties make to light sensing functions of animals.

Pineal organs in lower vertebrates can sense not only dark and light but also the ratio of ultraviolet (UV) light and visible light, namely "color." We previously found that the opsins involved in the pineal "color" detection were distinct from visual opsins and possess different molecular properties compared with those of visual opsins. Furthermore, one of the pineal opsin also expresses in the teleost parapineal organs, which are essential to form an asymmetric structure of the habenular nucleus, a part of brain, during its early development. In this study, we investigate physiological functions of "color" and UV detections in the pineal and parapineal organs, respectively, and also the contribution of opsin properties towards achievement of these functions.

【Research Methods】

We prepare and use mutant zebrafish in which the pineal opsins are replaced with visual opsins; in addition, we used opsin-gene knockout (KO) zebrafish. We measure the neural activities in the zebrafish brain by calcium imaging to investigate where in the brain and how the "color" information is transmitted. On the basis of the obtained results, we speculate relevant functions and conduct behavior tests with opsin-gene KO zebrafish. We also investigate contribution of pineal opsin properties in achieving the related functions by using opsin-replaced zebrafish. In addition, we also use the same mutants as described above to investigate how UV information captured in the parapineal organs transmits to the brain and whether the UV information contributes to forming habenular asymmetric structure.

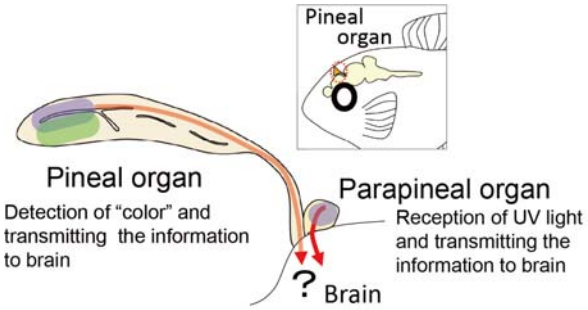

Figure 1: Pineal and parapineal organs and their light-sensing abilities

【Expected Research Achievements and Scientific Significance】

It is expected that findings of this study could contribute to understanding biological meanings of "color" sensing in extraocular organs and also the physiological relevance of UV information in non-visual photoreception. In addition, relationship between light and brain development could provide a new insight into not only basic biology but also applied biological science.

【Publications Relevant to the Project】

M. Koyanagi, E. Kawano, Y. Kinugawa, T. Oishi, Y. Shichida, S. Tamotsu and A. Terakita: Bistable UV pigment in the lamprey pineal. Proc. Natl. Acad. Sci. USA 101, 6687-6691 (2004)

T. Nagata, M. Koyanagi, H. Tsukamoto, S. Saeki, K. Isono, Y. Shichida, F. Tokunaga, M. Kinoshita, K. Arikawa and A. Terakita: Depth perception from image defocus in a jumping spider. Science 335, 469-471 (2012)

【Term of Project】

FY2015-2019

【Budget Allocation】

134,400 Thousand Yen

【Homepage Address and Other Contact Information】

http://www.sci.osaka-cu.ac.jp/biol/mphys/