PHOTIC REGULATION OF THE CHICKEN PINEAL CIRCADIAN CLOCK

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Light is a major environmental signal for entrainment of the circadian clock, but little is known about the phototransduction pathway triggered by light-activation of photoreceptive molecule(s) responsible for the phase shift of the clock in vertebrates. As the suprachiasmatic nucleus (SCN) governs the circadian rhythms in mammals, the pineal gland plays a pivotal role in regulation of circadian physiology in a wide range of non-mammalian vertebrates. The pineal gland of the chicken and the zebrafish produces melatonin in a circadian and light-dependent manner under the control of the endogenous oscillator, and it contains the autonomous circadian oscillators together with the photic entrainment pathway. Hence the chicken pineal gland provide useful experimental model for the study of the clock system at the cellular/molecular levels (reviewed in [1]), while transgenic studies are feasible in the zebrafish pineal gland by using a promoter that drives the pineal-specific gene expression [2].

Pinopsin expressed in the chicken pineal gland was the first example of non-visual opsins identified in non-retinal tissues of vertebrates [3]. Later we found expression of exo-rhodopsin in the zebrafish pineal gland [4] and VAL-opsin in the brain [5]. Pinopsin and exo-rhodopsin are members of G-protein-coupled receptors, and we previously demonstrated light-dependent activation of rod-type transducin α-subunit (Gt_1) in the chicken pineal gland [6]. It is unlikely, however, that the pineal Gt_1 plays a major role in the photic entrainment, because the light-induced phase shift was not affected by inhibiting chicken pineal Gt_1. Then we found the expression of G11 , an -subunit of another heterotrimeric G-protein, in the chicken pineal gland and retina by cDNA cloning, Northern blot and Western blot analyses[7]. G11 -immunoreactivity was colocalized with pinopsin in the chicken pineal cells and it was found predominantly at the outer segments of photoreceptor cells in the retinal sections, suggesting functional coupling of G11 with opsins in both the tissues [8]. By co-immunoprecipitation experiments using the retina, we showed the light- and GTP-dependent interaction between rhodopsin and G11 . In order to evaluate the role of light-dependent activation of G11, a Gq/11-coupled receptor was ectopically