

cardiac muscle potentials lacked the slow depolarization phase and they were inhibited by the application of TTX-containing saline. These results support the suggestion that prior to the end of the mysid stage this shrimp heart might be driven myogenically but a classic neurogenic drive is established in the following postlarval stages.

REVERSAL OF THE CHRONOTROPIC EFFECT OF DOPAMINE ON THE HEART DURING JUVENILE DEVELOPMENT OF THE ISOPOD CRUSTACEAN *LIGIA EXOTICA*

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We examined changes in dopamine modulation of the heart in association with the cardiac pacemaker transfer from the myocardium to the cardiac ganglion during juvenile development of the isopod crustacean *Ligia exotica*. In the myogenic heart of early juveniles, dopamine affected the myocardium and caused a decrease in the frequency and an increase in the duration of the myocardial action potential, resulting in negative chronotropic (decrease in beat frequency) and positive inotropic (increase in contractile force) effects on the heart. Contrastingly, in the heart of immature adults just after juvenile development, dopamine caused effects of adult type, positive chronotropic and positive inotropic effects on the heart affecting the cardiac ganglion and myocardium. During middle and late juvenile stages, dopamine caused individually a negative or a positive chronotropic effect on the heart. These results suggest that the chronotropic effect of dopamine on the *Ligia* heart is reversed from negative to positive in association with the cardiac pacemaker transfer from the myocardium to the cardiac ganglion during juvenile development.

OXYGEN TRANSPORT EFFICIENCY AND EFFECTIVENESS OF BOHR SHIFT IN FETAL AND MATERNAL BLOOD OF FIVE MAMMALIAN SPECIES

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Under physiological oxygen conditions, the effectiveness of the Bohr effect is high in fetal arterial blood and adult venous blood of five kinds of mammals. As efficiency of oxygen delivery is increased at physiological P50 and n values, the tendency that the effectiveness of the Bohr effect in arterial blood becomes high is observed. This tendency is also observed in adult arterial blood with a low effectiveness of the Bohr effect. Moreover, it has been known that cooperativity strongly affects the effectiveness of the Bohr effect. P50 showing the maximum effectiveness of the Bohr effect in venous blood was increased with an increase in n value, and finally became equal to the partial pressure of oxygen in venous blood. As the physiological oxygen environment and n value, P50 that brought about the maximum efficiency of oxygen delivery in five kinds of mammals is made to the maximum effectiveness of the Bohr effect in arterial blood nearly. Therefore, the effectiveness of the Bohr effect reaches maximal due to the relatively low physiological cooperativity (n = 2-3) of mammalian tetrameric Hb.

CONNECTIVE TISSUE OF THE SEA CUCUMBER *ACTYNOPIGA MAURITIANA*: CONTENT IN BODY AND OXYGEN CONSUMPTION COMPARED TO MUSCLES

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Sea cucumbers have lower oxygen consumption rate per wet weight (VO₂) when compared to other animals of the same size. The reason for this has been attributed to the high content of connective tissues whose VO₂ are speculated to be low. There are, however, no detailed reports on what extent connective tissues occupy the body and no measurements at all on VO₂ of connective tissues of sea cucumbers. We dissected out each organ to weigh and made the histological sections to estimate the volume of connective tissue and muscle in each organ. The connective tissue occupied about 70 % of the total tissue weight; muscles occupied only about 8 %. VO₂ was measured in body-wall dermis and in longitudinal body wall muscles. The dermis changes its mechanical properties and so does the muscles. We measured VO₂ of the connective tissue both in catch (stiff) state and out-of-catch (relaxed) state, and VO₂ of the muscles both in contracted state and relaxed state. VO₂ of the connective tissue was 1/14-1/4 of the muscle. These results established that the high percentage of the connective tissue with low VO₂ is the main factor why sea cucumbers show low VO₂.

ATP-MEDIATED CURRENTS RECORDED FROM RETINAL BIPOLAR CELLS

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It is generally accepted that ATP released from neurons or glial cells can function as either a neurotransmitter or a neuromodulator. Although it has been suggested that in the vertebrate retina ATP receptors are expressed on photoreceptors, bipolar cells and ganglion cells, little is known about physiological properties of the ATP receptors in the retina. Here we investigated whether or not the ATP receptors expressed on bipolar cells can generate a ligand-gated ionic current. Membrane currents in bipolar cells enzymatically dissociated from rat retinae were recorded under the whole-cell voltage-clamp conditions. ATP (0.2mM) evoked inward currents in 8 out of 46 cells tested. The currents which were larger at more hyperpolarized membrane potentials. The I-V curve is roughly linear and the currents reversed at around -25 mV. We interpret these observations as evidence that the ionotropic ATP receptors are expressed in a subset of retinal bipolar cells. Given the predominant role of bipolar cells in conducting visually-evoked signals to ganglion cells, these ATP-mediated currents may play a role in information processing within retina.

REGULATION OF PHOTOTRANSDUCTION BY SELECTED FARNESYLATION OF PHOTORECEPTOR G PROTEIN γ -SUBUNIT

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Transducin (T α /T β) is a member of heterotrimeric G protein family and plays a central role in phototransduction of retinal visual cells. T γ is selectively modified with farnesyl, whereas most of the other γ subtypes are geranylgeranylated. Farnesylation of T γ is essential for the signal-transducing function of transducin, and biochemical properties of T β are remarkably altered *in vitro* when farnesyl of T γ is replaced by geranylgeranyl. Here we studied *in vivo* the physiological significance of this selective farnesylation of T γ by using knock-in mice, in which farnesyl linked to T γ was switched to geranylgeranyl. The mutant mouse is normal in both retinal morphology and expression levels of retinal proteins, but geranylgeranylated T β associated with rod outer segment membranes more tightly than farnesylated T β . Remarkably, light-dependent translocation of T β in photoreceptor cell was suppressed in the mutant mouse, which exhibited severely impaired properties in light adaptation to stronger light. These results indicate the physiological importance of selective farnesylation over geranylgeranylation in regulation of the G protein-mediated signal transduction.

THE ROLE OF STATHMIN RELATED PROTEIN IN NEWT RETINA

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Japanese common newts (*Cynops pyrrhogaster*) have an ability to regenerate their injured organs. They can regenerate their neural retina from retinal pigment epithelial cells even in the adults. We have focused on a cytoplasmic phosphoprotein, stathmin. Stathmin functions as an intracellular relay in signal transduction, binds tubulin and destabilizes cellular microtubules. It has been proposed that stathmin plays roles in neural cells, for example the regulation of mitosis, the maintenance of cell structure and the extension of axons.

We isolated a stathmin gene from a cDNA library constructed from regenerating newt retinas. *In situ* hybridization analysis showed that stathmin mRNA was strongly expressed in entire regenerating retina, while hybridization signal was weaker in ganglion cell layer, inner nuclear layer and outer nuclear layer of adult normal retina. Furthermore, our immunohistochemical analysis suggested that stathmin was localized especially in inner plexiform layer and a part of photoreceptor cells and optic nerve. These results imply that newt stathmin play some roles in newt retinal structure and regeneration.

SUBCELLULAR LOCALIZATIONS OF G β IN MEDAKA CONE PHOTORECEPTORS

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It has been reported that tetrapods have only one type of PD expressed in both rods and cones, but teleosts have two isoforms of PDs selectively expressed in either rods or cones. In order to study the function of G β -PD system in teleost cones, we investigated medaka photoreceptors.

We have previously reported antiserum, anti-G β C, raised against partial peptide of medaka cone-specific subtype of G β (O1-G β 6). In this report, we further carried out double staining with anti-G β C and anti-CN, medaka cone-type PD (O1PD-C) specific antiserum. Our observations revealed that O1-G β 6 was distributed in all over the cone photoreceptors. On the other hands, anti-CN antiserum recognized whole of the cone cells, except for outer segments. Filamentous structures were observed on one side of cones, in which we could observe O1PD-C colocalizing with O1-G β 6.