The human body is made up of more than 200 different types of cells. How these diversified cell types are formed is one of the fundamental questions in developmental biology and regenerative medicine. To understand the developmental mechanisms underlying the cellular diversity and find a cue to regenerate human body parts when lost, we are focusing on the studies of eye and limb development and regeneration using model organisms of vertebrates (mouse, chick) as well as an insect (cricket).

**Our Research Projects**

1. Studies on functions and mechanisms of differentiation of novel opsin-expressing cells in the retina and deep brain (Fig. 1)
   The vertebrate retina consists of morphologically and functionally different cells; therefore, it is a paradigm to study the mechanisms of cellular differentiation. We previously showed that a novel opsin (a protein moiety of a photo-pigment), opsin 5, which is an ultraviolet sensor, is localized in small subsets of retinal and brain cells. It is intriguing to know the functions of such ultraviolet sensor in the retina and hypothalamus. Also, we aim to clarify the regulatory mechanisms of such opsin gene expression and to study the basic mechanisms of cellular differentiation of the neuronal cells.

2. Analysis of molecular basis for tissue regeneration using an emerging model insect *Gryllus bimaculatus* (Fig. 2)
   Once we lose a limb, we cannot regenerate the lost part. However, many animals such as lizards, newts, and frogs can regenerate lost body parts. Genetic background of regenerative and non-regenerative animals including humans are quite similar, suggesting that no special genes are required for tissue regeneration, but the presence of a difference in reactivation of gene expression after tissue loss. We analyze gene expression during tissue regeneration in an emerging model insect *Gryllus bimaculatus* to understand genetic basis of regeneration. Our final goal is to regenerate the lost body part of mammals on the basis of these basic studies.

3. Studies on bone formation and remodeling (Fig. 3)
   Our bony tissues are constantly remodeled through bone formation by osteoblasts and bone resorption by osteoclasts. Abnormalities in functions of these cells further complicate the pathophysiology of osteoporosis, osteogenesis imperfecta, and inflammatory osteolysis in rheumatoid arthritis and osteomyelitis. These refractory diseases have no absolute remedies right now. We aim to find a medicine for these bone diseases by seeking novel molecules which can regulate bone metabolism.

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