Visual Monitoring of Neural Activity in Hydra

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The nervous system is one of the most complicated systems, not only structurally, but functionally in regulating behavioral and physiological processes. Because of its structural complexity and diversity, it is technically difficult to investigate the relation between activity of neurons and behavior even with advanced technologies. Hydra is used in this project for neurobiology research because its nervous system, termed nerve net, is simple in structure. However, its size of about 1 cm and diverse and complicated behavior in 3D space has made it difficult to analyze the relation between neural activity and behavior. The purpose of this research is to develop a novel, accurate method to visualize the neural activity and behavior of the full Hydra organism simultaneously. The regenerative capacity of Hydra was used to benefit this project. Hydra tissue, when excised in small tissue pieces (1/30 of an adult), can regenerate into a "miniature" adult Hydra (0.5 - 1mm). This small size of the regenerated Hydra makes it easy to observe both neural activity and behavior. In addition, GCaMP, which is a genetically encoded Ca2+ indicator, was used to visualize the neural activity of various types of neural networks present in Hydra. The visualization and monitoring of the Hydra neural network was successful at 20X magnification, which enabled observation of neurological activity in a freely behaving Hydra. This technique will allow neuroscientists to study the response of Hydra to external stimuli, in addition to investigating the hypothesis that Hydra has no central nervous system.

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