1TA3-02 PSD タンパク質 Homer と Shank が形成するネットワーク構造 The Postsynaptic Density Proteins Homer and Shank Form a Polymeric Network Structure

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The postsynaptic density (PSD) is crucial for synaptic functions, but the molecular architecture retaining its structure and components remains elusive. Homer and Shank are among the most abundant scaffolding proteins in the PSD, working synergistically for maturation of dendritic spines. Here, we demonstrate that Homer and Shank, together, form a mesh-like matrix structure. Crystallographic analysis of this region revealed a pair of parallel dimeric coiled-coils intercalated in a tail-to-tail fashion to form a tetramer, giving rise to the unique configuration of a pair of amino-terminal EVH1 domains at each end of the coiled-coil. In neurons, the tetramerization is required for structural integrity of the dendritic spines and recruitment of proteins to synapses. We propose that the Homer-Shank complex serves as a structural framework and as an assembly platform for other PSD proteins.

Reference : Hayashi MK, et al: Cell (2009) 137: 159-171

1TA3-03 海洋深層水は海馬のインスリン様成長因子－Ⅰ産生を促進してマウスの認知機能を改善する

Deep-sea water improves cognitive function in mice by increasing the production of insulin-like growth factor-I in the hippocampus

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Insulin-like growth factor-I (IGF-I) has beneficial effects on the cognitive function. Deep-sea water (DSW) has biological effects similar to those of IGF-I. In the present study, we examined whether DSW may increase IGF-I production in the hippocampus by stimulating sensory neurons in the gastrointestinal tract, thereby improving the cognitive function in mice. Native, desalted, and distilled DSW increased calcitonin gene-related peptide (CGRP) release and cAMP levels in dorsal root ganglion (DRG) neurons isolated from wild-type (WT) mice. Increases of the tissue levels of CGRP, IGF-I, and the immunohistochemical expression of IGF-I were observed in the hippocampus at 4 weeks after oral administration of desalted and distilled DSW in WT mice. Significant enhancement of angiogenesis and neurogenesis was observed in the dentate gyrus of the hippocampus of the WT mice after administration of desalted and distilled DSW. Oral administration of desalted and distilled DSW to WT mice resulted in an increase in the expression of *c-fos* in the spinal dorsal horn, the parabrachial nuclei, solitary tract nucleus and the hippocampus. Significant improvement of spatial learning in the Morris water maze was observed in the WT mice after administration of desalted and distilled DSW. None of effects of desalted and distilled DSW in the WT mice were observed following the administration of desalted and distilled DSW in CGRP- knockout (CGRP-/-) mice. These observations strongly suggest that DSW may increase the hippocampal IGF-I production via sensory neuron stimulation in the gastrointestinal tract, thereby improving the cognitive function in mice. Such effects of DSW might not be dependent of minerals contained abundantly.

1TA3-04 培養神経回路網の長期間発達過程における免疫蛍光染色像と電気活動

Immunofluorescence imaging and electrical activity during long term development of cultured neuronal networks

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Multi-electrode arrays (MEAs) are used for investigation of electrical activities in neuronal networks in vitro. Using the system, spontaneous firing and synchronized burst are measured during growing process of networks. Although many studies have been presented using MEAs, the correlation between neuronal networks and electrical activities is not clarified. Therefore, we constructed a new system to investigate spatiotemporal dynamics of cultured neural networks. Using the system, we conducted a series of experiments such as long term culture over a few month, parallel data acquisition, huge data processing, confocal laser scanning microscopy, and scanning electron microscopy.

The dissociated cells of rat cortex were plated on plural dishes of 64 electrode planar MEAs (Alpha MED Sciences Co., Ltd.). The cells were cultured under a conventional condition. Electrical activity was recorded with a sampling rate of

20 kHz. Spikes were detected at each electrode by a cluster cutting procedure. Obtained spike data were analyzed in terms of dynamical systems approach. To clarify the morphological properties of the network, after recording neuronal activities, immunocytochemistry of the neurons was performed at the different culture days in vitro. The elemental parts of the network were visualized with staining cell bodies, dendrites, axons, excitatory presynapses, inhibitory presynapses, and glial cells. Fluorescence images were captured using a confocal laser scanning microscope. More detailed structural images were also obtained by a scanning electron microscope. In the presentation, we show the new system and the quantitative analysis of experimental data.

1TA3-05 構成論的アプローチによる昆虫匂い識別機構の分析

A Synthetic Approach for Understanding Olfactory Information Processing in the Moth Brain

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Here we report a method to analyze the functions of invertebrate neural circuits by use of reconstruction of virtual neuronal population. We investigated the functional organization of the moth antennal lobe (AL), the primary olfactory network, using *in vivo* intracellular recording and anatomical identification. The moth AL contains about 60 processing units called glomeruli that are identifiable from one animal to another and then different individuals have conserved organization. We were able to monitor the output information of the AL by recording the activity of a population of output neurons, each of which innervated a single glomerulus. Using compiled electrophysiological recordings and staining data from different animals, we mapped the odor-evoked dynamics on a digital atlas of the AL and geometrically reconstructed the population activity. First, this gives the evidence of ensemble representation for olfactory information. Second, the discriminability of this population changed with time. We also could estimate the functional connectivity among glomeruli, which are probably mediated by local interneurons. Superficial glomeruli may have strong connections whereas connections among deep glomeruli were rare, suggesting the AL has a heterogeneous functional organization during olfactory processing.

1TA3-06 資源競合振動子ネットワーク：粘菌ニューロコンピュータのモデル

Resource-competing oscillator network: A model of amoeba-based neurocomputer

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An amoeboid organism, the true slime mold *Physarum polycephalum*, exhibits rich spatiotemporal oscillatory behavior and various computational capabilities. Previously, the authors constructed a neurocomputer incorporating the amoeba as a computing substrate. Introducing optical feedback to implement a recurrent neural network model, we induce that the amoeba's photosensitive branches grow or degenerate in a network-patterned chamber in search of an optimal solution to the traveling salesman problem (TSP). The solution is represented by the amoeba's stably relaxed configuration (shape) in which its body area is maximized while the risk of being illuminated is minimized. The system reached the optimal solution of the four-city TSP with a high probability. Moreover, the system found more than one solution, as the amoeba's oscillatory behavior spontaneously switched between the stabilizing and destabilizing modes. In this study, considering the amoeba to be a network of oscillators coupled such that they compete for constant amounts of resources, we present a model of the amoeba-based neurocomputer. The model generates a number of spatiotemporal oscillation modes and produces not only simple behavior to stabilize a single mode but also complex behavior to spontaneously switch among different modes, which reproduces well the experimentally observed behavior of the amoeba. We established a test problem used to compare computational performances of the oscillation modes. The problem is a kind of optimization problem of how to allocate a limited amount of resource to oscillators such that conflicts among the oscillators can be minimized. We show that the complex behavior enables to attain a wider variety of solutions to the problem and produces better performances compared with the simple behavior.

1TA3-07 コントラスト変調と異常分散を用いた膜蛋白質結晶中の脂質二重膜の可視化

Visualization of lipid bilayer in the crystal of the membrane protein using x-ray contrast variation and anomalous scattering

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Dynamics of lipid bilayer plays a crucial role in the functions of membrane proteins. We grow Ca^{2+} -ATPase crystals by adding phospholipids and have determined the crystal structures in 9 different intermediate states. Thus our crystals provide a rare opportunity in which we can visualize the interactions of phospholipids with a membrane protein. Transmembrane helices of Ca^{2+} -ATPase move up and down and bend in the transition from E2 (low-affinity state to Ca^{2+})