Goα). Then, these fusion proteins were co-expressed with δ-opioid receptor (DOR), and channel α2/δ1 and β1 subunits in baby hamster kidney cells and Xenopus oocytes. Ba^{2+} currents through the expressed channels, their I-V relationships and G protein-mediated inhibition of the channels via DOR stimulation by the agonist enkephalin in α1B-FP and FP-Goα were similar to those obtained from wild-type α1B and Goα. The ratio of acceptor/donor fluorescent intensity was measured after donor and acceptor crosstalk was subtracted. In a conventional epifluorescence microscope, the ratio of acceptor (α1B-YPet)/donor (CyPet-Goα) intensity was gradually increased by enkephalin during 8 min. Next, using a total internal reflection fluorescence microscope, characteristics of one-step photobleaching were identified as single protein molecules on the cell membrane. Enkephalin inhibited the lateral mobilities of both α1B-EGFP and EGFP-Goα to 50% by 3 min, and the inhibited mobilities almost fully recovered by 5–10 min. In the single-molecule FRET configuration, enkephalin enhanced the ratio of acceptor (TagRFP-Goα)/donor (α1B-EGFP) intensity during 3 min, and this enhancement was decreased thereafter. These results indicate that receptor stimulation-induced enhancement of the interaction between G protein and N-type Ca^{2+} channel is reproducible at the single-molecule level.

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P1-a15 Firing properties of medium spiny projection neuron in striatum could be modulated by the long-lasting spontaneous calcium rhythm

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The striatum plays an important role in linking cortical activity to basal ganglia outputs. It was reported that firing frequency was increased in the case of Parkinson's disease in the striatum. This phenomenon was accounted by dopamine depletion in the striatum. However, underlying mechanisms of the effect of the dopamine to the firing activities were not fully understood. We reported that the long-lasting spontaneous transients of intracellular Ca^{2+} concentration ($[Ca^{2+}]_i$) (Ca^{2+} rhythm), which lasted up to about 300 s, both in the neurons and astrocytes. This Ca^{2+} rhythm was blocked by dopamine administration. But, the physiological meanings of the spontaneous Ca^{2+} rhythm was remain unclear. Thus, to propose the meanings of the spontaneous Ca^{2+} rhythm, we demonstrated the effect of the Ca^{2+} rhythm to the firing properties in the striatal medium spiny projection neuron (MSN) with the computer simulation.
For computer simulation, the NEURON simulation environment was used. We made the morphological model of MSN, and the ion channel models were incorporated to the model MSN. The following ion channel models were created and incorporated; Kv1, Kv4, KCNQ (Kv7), inward rectifier K channel, large and small conductance Ca^{2+} dependent K^+ channels (BK and SK), and voltage gated Na^+ channel. With this MSN model, we conducted "Ca^{2+}-clamp" simulation experiments, and investigated the relationship between $[Ca^{2+}]_i$ and the firing properties. $[Ca^{2+}]_i$ was varied within 50–1000 nM, corresponding to the $[Ca^{2+}]_i$ range of the spontaneous Ca^{2+} rhythm.
In MSN model with BK and SK channels, the interspike interval was prolonged by increase in $[Ca^{2+}]_i$. This observation did not alter with or without BK channel. However, in case of removing SK channel from the model cell, $[Ca^{2+}]_i$ sensitivity to the firing rate decreased. These results suggested that the spontaneous Ca^{2+} rhythm, which was blocked by dopamine, could modulate the firing activity of MSN via Ca^{2+}-SK channel signal cascade.

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P1-a17 AMPA receptor-mediated signaling acts on K_{ATP} channel and exocytosis in pancreatic beta-cells

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Pancreatic islets are responsible for insulin secretion by complex but highly ordered mechanisms. Glutamate receptors (GluRs) are mainly expressed in the central nervous system and play critical roles in neuronal processes, such as neuronal development and synaptic plasticity. Increasing evidence suggests that ionotropic glutamate receptors (iGluRs; AMPA, NMDA and kainate receptors) are expressed in islets and insulinoma cells, and probably involved in the control of insulin secretion. However, the exact role that glutamate receptors play in insulin secreting cells remains unclear or controversial. In the present study, we were the first to utilize pancreatic slice patch-clamp recording to measure functional AMPA receptor (AMPAR)-mediated currents and their actions in β cell exocytosis. In freshly prepared pancreatic slices, local application of glutamate induced apparent inward currents at both normal and high glucose levels. β cell exocytosis was significantly changed by AMPAR activation in a pathway independent to Ca^{2+} influx supported by unchanged intracellular Ca^{2+}-sensitive fluorescence and dominant expression of GluR2 in islet. The antagonist of AMPAR, CNQX, could greatly modulate the adenosine triphosphate-sensitive potassium channel (K_{ATP})-mediated voltage burst duration and interval in bath of high concentration glucose. Further study showed that glutamate application largely increased the sensitivity of K_{ATP} to intracellular ATP. Taken together, these data suggest that AMPAR progressively modulate K_{ATP} channel-mediated bursts and exocytosis.

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P1-a20 Nanosculpting reversed wavelength sensitivity into a photoswitchable iGluR

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To control neural activity remotely and reversibly with spatial and temporal precision we have developed light-activated ionotropic glutamate receptors. We employed the kainite receptor subunit, iGluR6, and photoswitched iGluR6 using a series of maleimde-azobenzene-glutamate (MAG) compounds, which dangled 2R,4R-allyi glutamate:G from a linker containing the photoisomerizable azobenzene:A that was attached to introduced cysteines via maleimide:M. Three MAGs with different linker lengths were examined at 16 cysteine positions around the mouth of the ligand binding domain (LBD) clamshell. After screening of the 48 combinations by light-induced activation of Ca2+ influx and whole-cell patch clamping, we found 2 kinds of photoswitchable nanomachine:LiGluR&yin/yang. A short version of MAG turned LiGluR&yin/yang on in either the *cis* or *trans* state, depending on the point of attachment around LBD. This LiGluR&yin/yang optical control made it possible for 1 wavelength of light to elicit action potentials in one set of neurons, while deexciting another set of neurons in the same preparation. The results provide insight into the properties of azobenzene photo-leashes and a functional probe of clamshell structure. Moreover, it shows the possibility to control cell membrane potential and neural activity with different wavelength light *in vivo*.

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P1-a21 The spatial-temporal characteristics of synaptic EPSP summation on the dendritic trees of hippocampal CA1 pyramidal neurons using laser uncaging stimulation

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In contrast to the Hebb type learning rule, in the spatiotemporal learning rule (STLR) proposed by Tsukada et al. (1996), the synaptic strength is modified by both spatial coincidence and the temporal summation of synaptic inputs without back-propagating action potentials (BPAP). When a pair of strong and weak stimulation is applied simultaneously in hippocampal CA1, heterosynaptic associative LTP, a physiological form of evidence of STLR, is induced in both stimulation sites. Our previous study showed that heterosynaptic associative LTP could be induced under decreased-BPAPs condition using low TTX application. However, the mechanism of LTP was unclear. In the present study, we aimed to clarify the mechanisms of heterosynaptic LTP-based electric interaction on the membrane by strong and weak inputs in the proximal dendrite. Membrane responses were recorded from CA1 pyramidal neurons of rat hippocampus acute slices by using whole-cell patch-clamp methods. Stimuli were applied to dendrites using by confocal laser microscope with high speed laser uncaging equipment. Here we