Curriculum Vitae

Masayoshi Mishina
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Academic degrees

1971, B. S., Kyoto University Faculty of Engineering
1973, M. S., Kyoto University Faculty of Engineering
1977, Ph. D., Kyoto University Faculty of Engineering

Postdoctoral training

1977~1978, Postdoctoral Fellow, Department of Medical Chemistry,
Kyoto University Faculty of Medicine, Japan
1978~1980, Postdoctoral Fellow, Institute of Biochemistry,
University of Erlangen-Nürnberg, West Germany
1980~1981, Postdoctoral Fellow, Institute of Molecular Biology,
University of Zürich, Switzerland

Professional experience

1981, Assistant Professor, Department of Medical Chemistry,
Kyoto University Faculty of Medicine
1981~1990, Associate Professor, Department of Medical Chemistry,
Kyoto University Faculty of Medicine
1990~1993, Professor, Department of Neuropharmacology,
Brain Research Institute, Niigata University
1993~1997, Professor, Department of Pharmacology, Faculty of Medicine,

The University of Tokyo
1997~2012, Professor, Department of Molecular Neurobiology and Pharmacology, Graduate School of Medicine, The University of Tokyo
2009~2011, Director, Center for Disease Biology and Integrative Medicine, Faculty of Medicine, The University of Tokyo
2012~2013, Visiting Professor, The Research Organization of Science and Technology, Ritsumeikan University
2012, Professor Emeritus, The University of Tokyo
2013~2018, Professor, Brain Science Laboratory, The Research Organization of Science and Technology, Ritsumeikan University
2018~Present, Visiting Professor, Brain Science Laboratory, The Research Organization of Science and Technology, Ritsumeikan University

Honors

1985 The Japanese Biochemical Society Encouragement Prize
1993 Tsukahara Nakaakira Memorial Award
1995 Tokyo Technoforum Gold Prize
2003 Fujiwara Prize
2010 Medal with Purple Ribbon
2010 Ebashi Setsuro Award
2012 The Takeda Prize for Medical Science
2016 The Japan Academy Prize
2020 The Order of the Sacred Treasure, Gold Rays with Neck Ribbon

Professional memberships and social activities

Neuropharmacology, Executive Editor (1993~2006)
Trends in Pharmacological Sciences, Advisory Editorial Board (2000~2018)
Journal of Neurochemistry, Deputy Chief Editor (2004~2011)
The Japanese Pharmacological Society, President (2006~2008), Director (200~2012, 2004~2006, 2008~201)
Chairman of the 79th Annual Meeting of the Japanese Pharmacological

Society (2006)
Japanese Biochemical Society, President (2007-2008),
Director (2000~2001, 2006~2007)
Japan Neuroscience Society, Director (1999~2004, 2008~2010)
The Molecular Biology Society of Japan
Society for Neuroscience
Science Council of Japan, Member (2005-2011), Associative Member
(2011~Present)
International Union of Basic and Clinical Pharmacology,
Second Vice President (2006~2010)
Asia Pacific Federation of Pharmacologists, President (2016~2021),
Vice President (2011~2016)

Selected publications

Mishina, M., Kurosaki, T., Tobimatsu, T., Morimoto, Y., Noda, M., Yamamoto, T., Terao, M., Lindstrom, J., Takahashi, T., Kuno, M. and Numa, S. (1984) Expression of functional acetylcholine receptor from cloned cDNAs. **Nature** 307, 604-608.

Mishina, M., Tobimatsu, T., Imoto, K., Tanaka, K., Fujita, Y., Fukuda, K., Kurasaki, M., Takahashi, H., Morimoto, Y., Hirose, T., Inayama, S., Takahashi, T., Kuno, M. and Numa, S. (1985) Location of functional regions of acetylcholine receptor α-subunit by site-directed mutagenesis. **Nature** 313, 364-369.

Takai, T., Noda, M., Mishina, M., Shimizu, S., Furutani, Y., Kayano, T., Ikeda, T., Kubo, T., Takahashi, H., Takahashi, T., Kuno, M. and Numa, S. (1985) Cloning, sequencing and expression of cDNA for a novel subunit of acetylcholine receptor from calf muscle. **Nature** 315, 761-764.

Sakmann, B., Methfessel, C., Mishina, M., Takahashi, T., Takai, T., Kurasaki, M., Fukuda, K. and Numa, S. (1985) Role of acetylcholine receptor subunits in gating of the channel. **Nature** 318, 538-543.

Mishina, M., Takai, T., Imoto, K., Noda, M., Takahashi, T., Numa, S., Methfessel, C. and Sakmann, B. (1986) Molecular distinction between fetal and adult forms of muscle acetylcholine receptor. **Nature** 321, 406-411.

Kubo, T., Fukuda, K., Mikami, A., Maeda, A., Takahashi, H., Mishina, M., Haga, T., Haga, K., Ichiyama, A., Kangawa, K., Kojima, M., Matsuo, H., Hirose, T. and Numa, S. (1986) Cloning, sequencing and expression of complementary DNA encoding the muscarinic acetylcholine receptor. **Nature** 323, 411-416.

Imoto, K., Methfessel, C., Sakmann, B., Mishina, M., Mori, Y., Konno, T., Fukuda, K., Kurasaki, M., Bujo, H., Fujita, Y. and Numa, S. (1986) Location of a δ-subunit region determining ion transport through the acetylcholine receptor channel. **Nature** 324, 670-674.

Fukuda, K., Kubo, T., Akiba, I., Maeda, A., Mishina, M. and Numa, S. (1987) Molecular distinction between muscarinic acetylcholine receptor subtypes. **Nature** 327, 623-625.

Fukuda, K., Higashida, H., Kubo, T., Maeda, A., Akiba, I., Bujo, H., Mishina, M. and Numa, S. (1988) Selective coupling with K^+ currents of muscarinic acetylcholine receptor subtypes in NG108-15 cells. **Nature** 335, 355-358.

Imoto, K., Busch, C., Sakmann, B., Mishina, M., Konno, T., Nakai, J., Bujo, H., Mori, Y., Fukuda, K. and Numa, S. (1988) Rings of negatively-charged amino acids determine the acetylcholine receptor channel conductance. **Nature** 335, 645-648.

Sakimura, K., Morita, T., Kushiya, E. and Mishina, M. (1992) Primary structure and expression of the γ2 subunit of the glutamate receptor channel selective for kainate. **Neuron** 8, 267-274.

Meguro, H., Mori, H., Araki, K., Kushiya, E., Kutsuwada, T., Yamazaki, M., Kumanishi, T., Arakawa, M., Sakimura, K. and Mishina, M. (1992) Functional characterization of a heteromeric NMDA receptor channel expressed from cloned cDNAs. **Nature** 357, 70-74.

Kutsuwada, T., Kashiwabuchi, N., Mori, H., Sakimura, K., Kushiya, E., Araki, K., Meguro, H., Masaki, H., Kumanishi, T., Arakawa, M. and Mishina, M. (1992) Molecular diversity of the NMDA receptor channel. **Nature** 358, 36-41.

Mori, H., Masaki, H., Yamakura, T. and Mishina, M. (1992) Identification by mutagenesis of a Mg^{2+} block site of the NMDA receptor channel. **Nature** 358, 673-675.

Sakimura, K., Kutsuwada, T., Ito, I., Manabe, T., Takayama, C., Kushiya, E., Yagi, T., Aizawa, S., Inoue, Y., Sugiyama, H. and Mishina, M. (1995) Reduced hippocampal LTP and spatial learning in mice lacking NMDA receptor ε1 subunit. **Nature** 373, 151-155.

Kashiwabuchi, N., Ikeda, K., Araki, K., Hirano, T., Shibuki, K., Takayama, C., Inoue, Y., Kutsuwada, T., Yagi, T., Kang, Y., Aizawa, S. and Mishina, M. (1995) Impairment of motor coordination, Purkinje cell synapse formation and cerebellar long-term depression in GluRδ2 mutant mice. **Cell** 81, 245-252.

Kutsuwada, T., Sakimura, K., Manabe, T., Takayama, C., Katakura, N., Kushiya, E., Natsume, R., Watanabe, M., Inoue, Y., Yagi, T., Aizawa, S., Arakawa, M., Takahashi, T., Nakamura, Y., Mori, H. and Mishina, M. (1996) Impairment of suckling response, trigeminal neuronal pattern formation and hippocampal LTD in NMDA receptor ε2 subunit mutant mice. **Neuron** 16, 333-344.

Takahashi, T., Feldmeyer, D., Suzuki, N., Onodera, K., Cull-Candy, S. G., Sakimura, K. and Mishina, M. (1996) Functional correlation of NMDA receptor ε subunits expression with the properties of single-channel and synaptic currents in the developing cerebellum. **J. Neurosci.** 16, 4376-4382.

Taniguchi, M., Yuasa, S., Fujisawa, H., Naruse, I., Saga, S., Mishina, M. and Yagi, T. (1997) Disruption of semaphorin III/D gene causes severe abnormality in peripheral nerve projection. **Neuron** 19, 519-530.

Kohmura, N., Senzaki, K., Hamada, S., Kai, N., Yasuda, R., Watanabe, M., Ishii, H., Yasuda, M., Mishina, M. and Yagi, K. (1998) Diversity revealed by a novel family of cadherins expressed in neurons at synaptic complex. **Neuron** 20, 1137-1151.

Kiyama, Y., Manabe, T., Sakimura, K., Kawakami, F., Mori, H. and Mishina, M. (1998) Increased thresholds for long-term potentiation and contextual learning in mice lacking the NMDA-type glutamate receptor ε1 subunit. **J. Neurosci.** 18, 6704-6712.

Mori, H., Manabe, T., Watanabe, M., Satoh, Y., Suzuki, N., Toki, S., Nakamura, K., Yagi, T., Kushiya, E., Takahashi, T., Inoue, Y., Sakimura, K. and Mishina, M. (1998) Role of the carboxyl-terminal region of the GluRε2 subunit in synaptic localization of the NMDA receptor channel. **Neuron** 21, 571-580.

Hayashi, T., Umemori, H., Mishina, M. and Yamamoto, T. (1999) The AMPA receptor interacts with and signals through the protein tyrosine kinase Lyn. **Nature** 397, 72-76.

Tsujita, M., Mori, H., Watanabe, M., Suzuki, M., Miyazaki, J. and Mishina, M. (1999) Cerebellar granule cell-specific and inducible expression of Cre recombinase in the mouse. **J. Neurosci.** 19, 10318-10323.

Yoshida, T., Ito, A., Matsuda, N. and Mishina, M. (2002) Regulation by protein kinase A switching of axonal pathfinding of zebrafish olfactory sensory neurons through the olfactory placode-olfactory bulb boundary. **J. Neurosci.** 22, 4964-4972.

Tokuoka, H., Yoshida, T., Matsuda, N. and Mishina, M. (2002) Regulation by glycogen synthase kinase-3β of the arborization field and maturation of

retinotectal projection in zebrafish. **J. Neurosci.** 22, 10324-10332.

Townsend, M., Yoshii, A., Mishina, M. and Constantine-Paton, M. (2003) Developmental loss of miniature *N*-methyl-D-aspartate receptor currents in NR2A knockout mice. **Proc. Natl. Acad. Sci. USA** 100, 1340-1345.

Fagiolini, M., Katagiri, H., Miyamoto, H., Grant, S. G. N., Mishina, M. and Hensch, T. (2003) Separable features of visual cortical plasticity revealed by *N*-methyl-D-aspartate receptor 2A signaling. **Proc. Natl. Acad. Sci. USA** 100, 2854-2859.

Matsuda, N. and Mishina, M. (2004) Identification of chaperonin CCT γ subunit as a determinant of retinotectal development by whole-genome subtraction cloning from zebrafish *no tectal neuron* mutant. **Development** 131, 1913-1925.

Kawakami, K., Takeda, H., Kawakami, N., Kobayashi, M., Matsuda, N. and Mishina, M. (2004) A transposon-mediated gene trap approach identifies developmentally regulated genes in zebrafish. **Dev. Cell** 7, 133-144.

Takeuchi, T., Miyazaki, T., Watanabe, M., Mori, H., Sakimura, K. and Mishina, M. (2005) Control of synaptic connection by glutamate receptor δ2 in the adult cerebellum. **J. Neurosci.** 25, 2146-2156.

Yoshida, T. and Mishina, M. (2005) Distinct roles of calcineurin-nuclear factor of activated T-cells and protein kinase A-cAMP response element binding protein signaling in presynaptic differentiation. **J. Neurosci.** 25, 3067-3079.

Takemoto-Kimura, S., Ishihara-Ageta, N., Nonaka, M., Adachi-Morishima, A., Mano, T., Okamura, M., Fujii, H., Fuse, T., Hoshino, M., Suzuki, S.,

Kojima, M., Mishina, M., Okuno, H. and Bito, H. (2007) Regulation of dendritogenesis via a lipid raft-associated Ca^{2+}/calmodulin-dependent protein kinase CLICK-III/ CaMKIγ. **Neuron** 54, 755-770.

Uemura, T., Kakizawa, S., Yamasaki, M., Sakimura, K., Watanabe, M., Iino, M. and Mishina, M. (2007) Regulation of long-term depression and climbing fiber territory by glutamate receptor δ2 at parallel fiber synapses through its C-terminal domain in cerebellar Purkinje cells. **J. Neurosci.** 27, 12096-12108.

Uemura, T., Lee, S., Yasumura, M., Takeuchi, T., Yoshida, T., Ra, M., Taguchi, R., Sakimura, K. and Mishina, M. (2010) *Trans*-synaptic interaction of GluRδ2 and neurexin through Cbln1 mediates synapse formation in the cerebellum. **Cell** 141, 1068-1079.

Ohno, T., Maeda, H., Murabe, N., Kamiyama, T., Yoshioka, N., Mishina, M. and Sakurai, M. (2010) Specific involvement of postsynaptic GluRN2B-containing NMDA receptors in the developmental elimination of corticospinal synapses. **Proc. Natl. Acad. Sci. USA** 107, 15252-15257.

Larsen, R. S., Corlew, R. J., Henson, M. A., Roberts, A. C., Mishina, M., Watanabe, M., Lipton, S. A., Nakanishi, N., Pérez-Otaño, I., Weinberg, R. J., and Philpot, B. D. (2011) NR3A-containing NMDA receptors promote neurotransmitter release and spike timing-dependent plasticity. **Nature Neurosci.** 14, 338-344.

Yoshida, T., Yasumura, M., Uemura, T., Lee, S., Ra, M., Taguchi, R., Iwakura, Y. and Mishina, M. (2011) IL1RAPL1 associated with mental retardation and autism mediates synapse formation by trans-synaptic interaction with PTPδ. **J. Neurosci.** 31, 13485–13499.

Yoshida, T., Shiroshima, T., Lee, S., Yasumura, M., Uemura, T., Chen, X.,

Iwakura, T. and Mishina, M. (2012) Neuronal isoform of an essential subunit of receptors for interleukin-1 family cytokines organizes synaptogensis in the brain. **J. Neurosci.** 32, 2588-2600.

Lee, S., Uemura, T., Yoshida, T. and Mishina, M. (2012) GluRδ2 assembles four neurexins into *trans*-synaptic triad to trigger synapse formation. **J. Neurosci.** 32, 4688-4701.

Harayama, T., Eto, M., Shindou, H., Kita, Y., Otshubo, E., Hishikawa, D., Ishii, S., Sakimura, K., Mishina, M. and Shimizu, T. (2014) Lysophospholipid acyltransferases mediate phosphatidylcholine diversification to achieve the physical properties required in vivo. **Cell Metab.** 20, 295-305.

Yamasaki, M., Okada, R., Takasaki, C., Toki, S., Natsume, R., Sakimura, K., Mishina, M., Shirakawa, T. and Watanabe, M. (2014) Opposing role of NMDA receptor GluN2B and GluN2D in somatosensory development and maturation. **J. Neurosci.** 34, 11534-11548.

Yamagata, A., Yoshida, T., Sato, Y., Goto-Ito, S., Uemura, T., Maeda, A., Shiroshima, T., Iwasawa-Okamoto, S., Mori, H., Mishina, M. and Fukai, S. (2015) Mechanisms of splicing-dependent *trans*-synaptic adhesion by PTPδ–IL1RAPL1/IL-1RAcP for synaptic differentiation. **Nat. Commun.**, 6, 6926.

Zhang-Hooks, Y., Agarwal, A., Mishina, M. and Bergles, D. E. (2016) NMDA receptors enhance spontaneous activity and promote neuronal survival in the developing cochlea. **Neuron** 89, 337-350.

Galbraith, K. K., Fujishima, K., Mizuno, H., Lee, S., Uemura, T., Sakimura, K., Mishina, M., Watanabe, N. and Kengaku, M. (2018) MTSS1 regulation of actin-nucleating formin DAAM1 in dendritic filopodia determines final

dendritic configuration of Purkinje cells. **Cell Reports** 24, 95-106.

Itoh, M., Yamashita, M., Kaneko, M., Okuno, H., Abe, M., Yamazaki, M., Natsume, R., Yamada, D., Kaizuka, T., Suwa, R., Sakimura, K., Sekiguchi, M., Wada, K., Hoshino, M., Mishina, M. and Hayashi, T. (2018) Deficiency of AMPAR-palmitoylation aggravates seizure susceptibility. **J. Neurosci.** 38, 10220-10235.

Yoshida, T., Yamagata, A., Imai, A., Kim, J., Izumi, H., Nakashima, S., Shiroshima, T., Maeda, A., Iwasawa-Okamoto, S., Azechi, K., Osaka, F., Saitoh, T., Maenaka, K., Shimada, T., Fukata, Y., Fukata, M., Matsumoto, J., Nishijo, H., Takao, K., Tanaka, S., Okabe, S., Tabuchi, K., Uemura, T., Mishina, M., Mori, H. and Fukai, S. (2021) Canonical versus non-canonical transsynaptic signaling of neuroligin 3 tunes development of sociality in mice. **Nat. Commun.** 12, 1848.