

Jaekyung Kim

Curriculum Vitae

Department of Biological Sciences, Korea Advanced Institute of Science and Technology (KAIST)
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Born 1985, Jeonjoo, Republic of Korea

Education

Feb, 2010 – Feb, 2017 Integrated Master's and Ph.D. Program in Dept. of Bio and Brain Engineering, KAIST, Daejeon, South Korea

Feb, 2010 – Feb, 2017 Renaissance Program (special program for interdisciplinary research), KAIST, Daejeon, South Korea

Mar, 2006 – Feb, 2010 B.S. in Dept. of Biomedical Engineering, *Hanyang University*, Seoul, South Korea

Research Experience

Jul, 2023 – present Assistant Professor

Systems/computational neuroscience: Sleep-dependent memory processing and neuromodulatory system for motor learning.
Dept. of Biological Sciences, KAIST, South Korea.

Nov, 2017 – Jun, 2023 Postdoctoral Researcher

Systems/computational neuroscience: Understanding memory/systems processing of natural/injured brain for motor learning and brain-machine interface (BMI) in rodents and non-human primates.

PI: Karunesh Ganguly, Associate Professor, Dept. of Neurology, *University of California San Francisco*, USA. Neurology and Rehabilitation Service, San Francisco Veterans Affairs Medical Center, San Francisco, USA

Jun, 2017 – Nov, 2017 Postdoctoral Researcher

Computational electrochemistry: Estimation of neurochemicals detected with fast-scan cyclic voltammetry using principal component regression.

PI: In Young Kim, Professor, and **Dong Pyo Jang**, Professor, Dept. of Biomedical engineering, *Hanyang University*, South Korea.

Oct, 2013 – Feb, 2017 Combined M.S and Ph.D. Student

Theoretical/computational neuroscience: Theory of optimal balance between excitation and inhibition can predict properties of synaptic inhibition.

PI: Christopher Fiorillo, Associate Professor, Dept. of Bio and Brain Engineering, KAIST, South Korea.

Feb, 2010 – Oct, 2013 Combined M.S and Ph.D. Student

Neurophysiology: The role of A-type K⁺ channel and T-type Ca²⁺ channel in maintaining excitability in neuron.

PI: Christopher Fiorillo, Associate Professor, Dept. of Bio and Brain Engineering, KAIST, South Korea.

Aug 14, 2023

Publications (* Representative)

* **Kim, J.**, Joshi, A., Frank, L., Ganguly K. (2023) Cortical–hippocampal coupling during manifold exploration in motor cortex. *Nature*, 613, 103-110. doi: 10.1038/s41586-022-05533-z.

- It made an important discovery about the underlying neural basis of system consolidation of motor memory. While there is clear evidence that the hippocampus eventually transfers memories to cortex (i.e., ‘systems consolidation’), very little is known about the time course of transfer and how cortical representations are changed. Our study suggests a clear model that hippocampal sharp-wave ripples are associated with representational exploration in motor cortex during early motor learning and, after completion of exploration, hippocampal activity drops.

* **Kim, J.**, Gulati, T., Ganguly, K. (2019) Competing roles of slow oscillations and delta waves on memory consolidation versus forgetting. *Cell*, 179(2), 514-526. doi: 10.1016/j.cell.2019.08.040 (**the cover article**).

- It provides ground findings that fill a gap between the leading theories about the role of sleep in memory processing, termed the “synaptic homeostasis hypothesis” (SHY) and the “active systems consolidation” concept. I founded the dissociable features of slow waves from the published data (Gulati et al., 2017) and designed and performed real time closed-loop optogenetic experiments in the behaving rats to test the role of two types of slow waves and then analyzed all data.

* **Kim, J.**, Guo, L., Hishinuma, A., Lemke, S., Ramanathan, D.S., Won, S., Ganguly, K. (2022) Recovery of consolidation after sleep following stroke – interaction of slow waves, spindles and GABA. *Cell Reports*, 38, 110426, doi: 10.1016/j.celrep.2022.110426.

- It uses a novel distinction of spindle coupling to global slow-oscillations (SO) and local delta-waves (δ) found in my Cell publication (Kim et al., 2019) to show that post-stroke sleep is in a “forget state.” We found that the pathological sleep in forget state after stroke results in poor motor memory consolidation. Exciting part is the use of a pharmacological treatment ($\alpha 5$ -GABA_A receptor antagonist which reduces tonic inhibition) to alter sleep processing towards a physiological state during the early stroke period.

* **Kim, J.**, Fiorillo, C.D. (2017) Theory of optimal balance predicts and explains the amplitude and decay time of synaptic inhibition. *Nature Communications*, 8: 14566, doi: 10.1038/ncomms14566.

- It provides understanding why and how neurons keep balance between excitation and inhibition (E-I) using the previously published theory, termed the “predictive homeostasis” (Fiorillo, Kim, and Hong, 2014), I performed computational simulation using NEURON program and found optimal E-I balance closely matching to the experimental values across the broad range of brain areas.

Kim, H. **, **Kim, J.****, Khanna, P., Novik, L., Ganguly K. Bistable transition between neural population dynamics and beta oscillation in non-human primates (**in preparation**). ** co-first author

Darevsky, D. **, **Kim, J.****, Ganguly K. Coupling of slow oscillations in prefrontal and motor cortex predicts onset of spindle trains and persistent memory reactivations (**in preparation**). ** co-first author

Kim, J., Barath, A.S., Rusheen, A.E., Cabrera, J.R., Price, J.B., Shin, H., Jondal, D.E., Jang, D.P., Lee, K.H., Oh, Y. (2021) Automatic and reliable quantification of tonic dopamine concentrations in vivo using a novel probabilistic inference method. *ACS Omega*, 6, 6607-6613. doi: 10.1021/acsomega.0c05217

Kim, J., Oh, Y., Park, C., Kang, Y.M., Shin, H., Kim, I., Jang, D.P. (2019) Comparison study of partial least squares regression analysis and principal component analysis in fast scan cyclic voltammetry. *International Journal of Electrochemical Science*, 14, 5924-5937. doi: 10.20964/2019.07.03

Park, C., Oh, Y., Shin, H., **Kim, J.**, Kang, Y., Sim, J., ... Jang, D.P. (2018). Fast cyclic square-wave

voltammetry to enhance neurotransmitter selectivity and sensitivity. *Analytical Chemistry*, 90(22), 13348-13355. doi: 10.1021/acs.analchem.8b02920

Oh, Y., Heien, M.L., Park, C., Kang, Y.M., **Kim, J.**, Boschen, S.L., ... Jang, D.P. (2018). Tracking tonic dopamine levels in vivo using multiple cyclic square wave voltammetry. *Biosensors and Bioelectronics*, 121, 174-182. doi: 10.1016/j.bios.2018.08.034

Fiorillo, C.D., **Kim, J.**, Hong, S.Z. (2014) The meaning of spikes from the Neuron's point of view: Predictive homeostasis generates the appearance of randomness. *Frontiers in Computational Neuroscience*, 29: 8-49, doi: 10.3389/fncom.2014.00049

Patents

Kim, J. et al., Probabilistic inference for estimating tonic concentrations using multiple cyclic square wave voltammetry. U.S. Patent (**applied**)

Grants

09/30/21 - 08/31/26 Pathway to Independence Award K99/R00 (K99NS119737), NINDS, NIH, The role of sleep for motor recovery post stroke

04/01/21 - 10/01/21 AHA Postdoctoral Fellowship (award Number: 831442), American Heart Association (AHA), Enhanced sleep-dependent processing for motor recovery after stroke

09/01/18 - 08/31/19 Basic Science Research Program (2018R1A6A3A03013031), National Research Foundation of Korea (NRF), Improved performance of brain-machine interface by spindle modulation

Scholarships and Awards

2022	Award for the Excellent BME Presentation, US Korea Conference (UKC)
2022	Award for the Best Flash Talk, Korean Life Scientists in the Bay Area (KOLIS)
2021	KOLIS Fellowship, Korean Life Scientists in the Bay Area (KOLIS)
2020	Award for Excellent Research (for NRF grant 2018R1A6A3A03013031), Ministry of Education South Korea
2019	Postdoctoral Fellow Award, Association of Korean Neuroscientists (AKN)
2017	Award for Outstanding Ph.D. Dissertation, Dept. of Bio and Brain Engineering, KAIST
2010 - 2017	National Scholarship, Ministry of Science and Technology
2010	Award for <i>Summa Cum Laude</i> (undergraduate), Hanyang University
2006 - 2009	Excellent Grade Scholarship (every semester), Hanyang University
2008	Award for Outstanding Work-Study (The second place in the competition with the title of Globalization of Korean Biomedical Engineering), Hanyang University
2008	Student Research Scholarship, Center for Bio-Artificial Muscle, Hanyang University

Invited Talks

2023 UKOREA Neuro Symposium 2023 / Madalen College, Oxford, UK
2023 Department of Molecular Pharmacology and Experimental Therapeutics / Mayo Clinic, Rochester, USA
2023 Department of Convergence IT Engineering / POSTECH, Zoom online
2023 Department of Biomedical Sciences / Chonnam National University, Zoom online
2023 BRIC Webinar / Zoom online
2022 Department of Brain and Cognitive Sciences / SNU, Seoul, South Korea
2022 Biomedical Engineering Research Center / Samsung Medical Center, Seoul, South Korea
2022 KOSEN Bridge Forum / Zoom online
2022 Association of Korean Neuroscientists eTalk / Zoom online
2022 Department of Biomedical Engineering / Hanyang University, Seoul, South Korea
2022 Department of Biological Sciences / SNU, Seoul, South Korea
2022 Department of Biological Sciences / KAIST, Zoom online
2022 BRIC Webinar / Zoom online
2022 Yonsei University College of Medicine / Zoom online
2021 Department of Biological Sciences / UNIST, Zoom online
2021 Department of Biological Sciences / Seoul National University, Zoom online
2021 KOLIS Fellowship talk / Korean Life Scientists in the Bay Area (KOLIS) conference, Zoom
2021 Department of Cognitive Sciences / Hanyang University, Zoom online
2021 Korean Brain Engineering Conference / Zoom online
2021 SRC (Sloan-Kettering, Rockefeller, Cornell) seminar / Zoom online
2020 Department of Biomedical Engineering / Hanyang University, Zoom online
2020 KOLIS-SNUCM Symposium / Zoom online
2019 School of Biosystems and Biomedical Sciences / Korea University, Seoul, South Korea
2019 Department of Biomedical Engineering / Hanyang University, Seoul, South Korea
2019 Smart Research Center / Seoul Samsung Medical Center, Seoul, South Korea
2018 Korean Life Scientists in the Bay Area (KOLIS) conference, Palo alto, USA
2018 Annual Retreat of Center for Neural Engineering and Prostheses, San Francisco, USA
2017 University of California-San Francisco, San Francisco, USA
2017 Yale School of Medicine, New Haven, USA

Conference Presentations

Kim, J., Joshi, A., Frank, L., Ganguly K. (2022) Coordination of sleep slow oscillations and hippocampal sharp-wave ripples during manifold exploration in motor cortex. Annual Meeting of Society for Neuroscience, San Diego, USA. *Poster presentation*

Kim, H., **Kim, J.**, Khanna, P., Novik, L., Ganguly K. (2022) Bistability of beta oscillations and movement-related population spiking in motor areas. Annual Meeting of Society for Neuroscience, San Diego, USA. *Oral presentation*

Kim, J., Joshi, A., Frank, L., Ganguly K. (2022) Coordination of sleep slow oscillations and hippocampal sharp-wave ripples during manifold exploration in motor cortex. UKC, Washington D.C., USA. *Poster presentation*

Kim, J., Joshi, A., Frank, L., Ganguly K. (2022) Two-stage coordination of hippocampal sharp-wave ripples and sleep slow oscillations during manifold exploration in motor cortex. KSBNS, Songdo, South Korea. *Poster*

presentation

Kim, J., Joshi, A., Frank, L., Ganguly K. (2021) Role of hippocampal sharp-wave ripples in motor memory consolidation during sleep. Annual Meeting of Society for Neuroscience, online. *Poster presentation*

Kim, H., **Kim, J.**, Khanna, P., Novik, L., Ganguly K. (2021) Changes in neural population dynamics during stroke recovery in non-human primates. Annual Meeting of Society for Neuroscience, online. *Poster presentation*

Kim, J., Hishinuma, A., Guo, L., Won, S., Ganguly K. (2019) Changes in the coupling of slow-waves with spindles tracks motor recovery after stroke. Annual Meeting of Society for Neuroscience, Chicago, USA. *Poster presentation*

Ganguly K., Gulati, T., **Kim, J.** (2019) Competing Roles of Slow-Oscillations and Delta-Waves on Memory Consolidation versus Forgetting. Annual Meeting of Society for Neuroscience, Chicago, USA. *Poster presentation*

Kim, J., Hishinuma, A., Guo, L., Won, S., Ganguly K. (2019) Changes in the coupling of slow-waves with spindles tracks motor recovery after stroke. International Brain Research Organization, Daegu, Korea. *Poster presentation*

Kim, J., Gulati, T., Ganguly K. (2018) Closed-loop inhibition of spiking activity during slow oscillations and effects on spindles. Annual Meeting of Society for Neuroscience, San Diego, USA. *Poster presentation*

Kim, J., Park, C., Kim, I., Jang, D.P. (2017) Estimation of Neurotransmitters concentration by Fast Square Wave Cyclic Voltammetry and Principal Component Regression. Annual Meeting of Korean Society for Computational Neuroscience, Seoul, Korea. *Poster presentation*

Park, C., **Kim, J.**, Kang, Y., Shin, H., Cho, H., DeWaele, M., Jang, D.P. (2017) Large-Amplitude Fast Square Wave Cyclic Voltammetry (FSWCV) for differentiation of neurotransmitters. International Conference of the IEEE Engineering in Medicine and Biology Society, Jeju, Korea. *Poster presentation*

Kim, J., Fiorillo, C.D. (2016) Anti-Hebbian learning of optimal homeostatic IPSP amplitude and decay time. Annual Meeting of Society for Neuroscience, San Diego, USA. *Poster presentation*

Kim, J., Fiorillo, C.D. (2015) Evidence that the theory of predictive homeostasis explains the observed strength and decay rate of synaptic inhibition. Annual Meeting of Society for Neuroscience, Chicago, USA. *Poster presentation*

Kim, J., Fiorillo, C.D. (2014) Optimization of membrane excitability for predictive homeostasis of spike generation. Annual Computational Neuroscience Meeting (CNS 2014), Quebec, Canada. *Poster presentation*

Kim, J., Fiorillo, C.D. (2013) The Theory of predictive homeostasis may explain the properties of A-type potassium channels. Annual Meeting of Korean Society for Computational Neuroscience, Seoul, Korea. *Poster presentation*

Kim, J., Fiorillo, C.D. (2012) A-type potassium channels as a mechanism for predictive homeostasis of membrane excitability. Annual Meeting of Society for Neuroscience, New Orleans, USA. *Poster presentation*

Kim, J., Fiorillo, C.D. (2011) Evidence that density and inactivation rate of A-type potassium channels may be optimized to maintain a homeostatic level of excitability in the presence of synaptic inputs. Annual Meeting of the Korean Society of Medical and Biological Engineering, Seoul, Korea. *Poster presentation*

Park, J., **Kim, J.**, Kang, J., Lee, E., Kim, I., Kim, S.I., Ku, J. (2010) Increase of functional connectivity between the left and right hippocampus during navigation. Annual Meeting of Society for Neuroscience, San Diego, USA. *Poster presentation*

Park, J., Ku, J., **Kim, J.**, Kim, I., Kim, S.I. (2010) The analysis of the functional role and connectivity in human hippocampus using modified Directed Transfer Function (DTF). Annual Meeting of the Korean Society of Medical and Biological Engineering, Seoul, Korea. *Poster presentation*