



Kimberley Tolias

Professor (Research) of Anesthesiology, Perioperative and Pain Medicine

 Curriculum Vitae available Online

Bio

BIO

Kimberley Tolias, PhD, is a Professor in the Department of Anesthesiology, Perioperative and Pain Medicine at Stanford University School of Medicine. The Tolias laboratory studies the molecular and cellular mechanisms that govern neural circuit formation, plasticity, and repair in the mammalian central nervous system (CNS). In particular, the lab investigates how neurons sense extracellular cues and convert them into intracellular signaling pathways that control synapse development and remodeling, dendritic and axonal growth, and cell migration. The laboratory also examines how disruption of these pathways contributes to neurological and neuropsychiatric disorders including intellectual disability, autism spectrum disorder, Alzheimer's disease, depression, and chronic pain, and whether targeting specific signaling mechanisms can promote recovery following CNS injury or disease. To address these questions, the laboratory combines mouse genetics with state-of-the-art molecular, cellular, biochemical, electrophysiological, imaging, genomic, and behavioral approaches.

Research from the Tolias laboratory has provided fundamental insights into Rho GTPase signaling pathways that regulate synapse development and plasticity through control of cytoskeletal dynamics, as well as novel mechanisms that provide precise spatiotemporal regulation of Rho GTPase signaling in neurons and glia during CNS development. Her group has also identified important roles for the Adhesion-GPCR BAI1 in synapse and dendritic arbor development, defined functions for RhoA signaling in locomotor circuit assembly and cerebellar morphogenesis, and developed new approaches for preventing pathological synaptic remodeling caused by traumatic brain injury and radiation therapy. More recently, the laboratory has expanded into developing tools to identify synapses undergoing remodeling during learning or following injury, investigating mechanisms underlying chronic pain, opioid tolerance, and chronic pain-associated mood disorders, and exploring how the gut microbiome influences brain development, synaptic function, and behavior.

Dr. Tolias received her BS in Biochemistry from the University of Minnesota, graduating summa cum laude. She earned her PhD in Cell and Developmental Biology at Harvard Medical School, where she trained in the laboratory of Dr. Lewis Cantley studying signaling pathways that regulate the actin cytoskeleton and cell morphogenesis. She subsequently completed postdoctoral training in neurobiology in the laboratory of Dr. Michael Greenberg at Harvard Medical School, where she investigated molecular mechanisms linking neural activity to synaptic development and plasticity. Prior to joining Stanford, Dr. Tolias served for nearly 20 years on the faculty at Baylor College of Medicine, where she was a tenured Professor in the Departments of Neuroscience and Biochemistry and Molecular Pharmacology. Her research has been continuously supported by the National Institutes of Health and other major foundations and has been recognized by awards including the McKnight Memory and Cognitive Disorders Award and the NIH EUREKA Award.

ACADEMIC APPOINTMENTS

- Professor (Research), Anesthesiology, Perioperative and Pain Medicine
- Member, Bio-X

HONORS AND AWARDS

- McKnight Memory and Cognitive Disorders Award, McKnight Foundation (2016 - 2019)
- NIH EUREKA Award, NIH (2013 - 2017)
- Damon Runyon Cancer Research Fellowship, Damon Runyon (1999 - 2002)

PROFESSIONAL EDUCATION

- Postdoctoral Fellowship, Harvard Medical School , Neurobiology, Lab of Michael E. Greenberg (2006)
- PhD, Harvard Medical School , Cell and Developmental Biology, Lab of Lewis Cantley (1998)
- BS, University of Minnesota , Biochemistry (1992)

Research & Scholarship

CURRENT RESEARCH AND SCHOLARLY INTERESTS

The human brain is composed of billions of neurons connected through trillions of synapses that form the neural circuits underlying thought, emotion, learning, memory, and behavior. These synaptic connections are not static - they are continuously shaped and remodeled throughout life in response to experience, a processes critical for learning and memory. When neural circuits fail to develop or function properly, the consequences can be devastating, contributing to conditions ranging from autism spectrum disorder and intellectual disability to chronic pain, depression, schizophrenia, Alzheimer's disease, and cognitive decline.

Research in the Tolia laboratory seeks to understand the fundamental molecular and cellular mechanisms that govern how neural circuits form, adapt, and repair themselves in the mammalian central nervous system (CNS). Our work focuses on how neurons sense signals from their environment and convert them into intracellular signaling pathways that drive synapse formation and remodeling, dendritic and axonal growth, and cell migration. We are also interested in how disruption of these pathways contributes to neurological and neuropsychiatric disease, and whether targeting specific signaling mechanisms can promote recovery following CNS injury or disease.

The laboratory combines mouse genetics with molecular, cellular, biochemical, electrophysiological, genomic, and behavioral approaches to bridge fundamental neuroscience with translational discovery.

Current Research Areas:

- Molecular mechanisms regulating synapse development, neural circuit formation, and synaptic plasticity during learning and memory
- Roles of Rho GTPase signaling pathways in brain development, circuit remodeling, and neurological disease
- Functions of Adhesion-GPCRs in synapse development, dendritic and axonal growth, and neural circuit function
- Mechanisms underlying chronic pain, opioid tolerance, and chronic pain-associated mood and cognitive disorders

- Synaptic and circuit dysfunction following traumatic brain injury, radiotherapy, and other CNS injuries
- Development of new tools to visualize and map synaptic remodeling during learning and disease
- Interactions between the gut microbiome, brain development, neural circuit function, and behavior

Teaching

GRADUATE AND FELLOWSHIP PROGRAM AFFILIATIONS

- Neurosciences (Phd Program)

Publications

PUBLICATIONS

- **Infant gut microbiomes contribute to metabolic states that impact brain function.** *bioRxiv : the preprint server for biology*
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- **Adhesion G protein-coupled receptors.** *Pharmacological reviews*
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2026; 78 (3): 100116
- **Primary cortical neurons precipitate and extrude large mitochondria-associated calcium-phosphate sheets with a bone-precursor-like ultrastructure.** *Molecular brain*
Anderson, E. D., Cronkite, C. A., Baldwin, P. R., Abella, C. P., Duman, J. G., Simmonds, A. N., Waxham, M. N., Tolias, K. F., Ludtke, S. J.
2026; 19 (1): 11
- **Restoration of sFRP3 Preserves the Neural Stem Cell Pool and Spatial Discrimination Ability in a Mouse Model of Alzheimer's Disease.** *The Journal of neuroscience : the official journal of the Society for Neuroscience*
Fu, C. H., Park, J., Tosi, U., Blanco, F. A., Silva-Pérez, M., Muralidharan, K., You, J. C., Lee, M., Stephens, G. S., Zhang, X., Zheng, Y., Scharfman, H., Tolias, et al
2025; 45 (49)
- **Primary cortical neurons precipitate and extrude large mitochondria-associated calcium-phosphate sheets with a bone-precursor-like ultrastructure.** *bioRxiv : the preprint server for biology*
Anderson, E. D., Cronkite, C. A., Baldwin, P. R., Abella, C. P., Duman, J. G., Simmonds, A. N., Waxham, M. N., Tolias, K. F., Ludtke, S. J.
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- **Bright and photostable yellow fluorescent proteins for extended imaging.** *Nature communications*
Lee, J., Lai, S., Yang, S., Zhao, S., Blanco, F. A., Lyons, A. C., Merino-Urteaga, R., Ahrens, J. F., Nguyen, N. A., Liu, H., Liu, Z., Lambert, G. G., Shaner, et al
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- **The contribution of de novo coding mutations to meningomyelocele** *NATURE*
Ha, Y., Nisal, A., Tang, I., Lee, C., Jhamb, I., Wallace, C., Howarth, R., Schroeder, S., Vong, K., Meave, N., Jiwani, F., Barrows, C., Lee, et al
2025
- **Targeting Tiam1 Enhances Hippocampal-Dependent Learning and Memory in the Adult Brain and Promotes NMDA Receptor-Mediated Synaptic Plasticity and Function.** *The Journal of neuroscience : the official journal of the Society for Neuroscience*
Blanco, F. A., Saifullah, M. A., Cheng, J. X., Abella, C., Scala, F., Firozi, K., Niu, S., Park, J., Chin, J., Tolias, K. F.
2025; 45 (6)
- **Tiam1-mediated maladaptive plasticity underlying morphine tolerance and hyperalgesia.** *Brain : a journal of neurology*
Yao, C., Fang, X., Ru, Q., Li, W., Li, J., Mehsein, Z., Tolias, K. F., Li, L.
2024; 147 (7): 2507-2521

- **Correlative Cryo-FIB and Cryo-ET of Dendritic Spines and Synaptic Connections.** *Microscopy and microanalysis : the official journal of Microscopy Society of America, Microbeam Analysis Society, Microscopical Society of Canada*
Anderson, E. D., Cronkite, C. A., Tolias, K. F., Ludtke, S. J.
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- **Tiam1 coordinates synaptic structural and functional plasticity underpinning the pathophysiology of neuropathic pain.** *Neuron*
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- **Calpain activity is negatively regulated by a KCTD7-Cullin-3 complex via non-degradative ubiquitination.** *Cell discovery*
Sharma, J., Mulherkar, S., Chen, U. I., Xiong, Y., Bajaj, L., Cho, B. K., Goo, Y. A., Leung, H. E., Tolias, K. F., Sardiello, M.
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- **TIAM1-mediated synaptic plasticity underlies comorbid depression-like and ketamine antidepressant-like actions in chronic pain.** *The Journal of clinical investigation*
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- **Rac-maninoff and Rho-vel: The symphony of Rho-GTPase signaling at excitatory synapses.** *Small GTPases*
Duman, J. G., Blanco, F. A., Cronkite, C. A., Ru, Q., Erikson, K. C., Mulherkar, S., Saifullah, A. B., Firozi, K., Tolias, K. F.
2022; 13 (1): 14-47
- **Ketamine: Neuroprotective or Neurotoxic?** *Frontiers in neuroscience*
Choudhury, D., Autry, A. E., Tolias, K. F., Krishnan, V.
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- **The Rac-GEF Tiam1 Promotes Dendrite and Synapse Stabilization of Dentate Granule Cells and Restricts Hippocampal-Dependent Memory Functions.** *The Journal of neuroscience : the official journal of the Society for Neuroscience*
Cheng, J., Scala, F., Blanco, F. A., Niu, S., Firozi, K., Keehan, L., Mulherkar, S., Froudarakis, E., Li, L., Duman, J. G., Jiang, X., Tolias, K. F.
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- **Cell type composition and circuit organization of clonally related excitatory neurons in the juvenile mouse neocortex.** *eLife*
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2019; 8
- **An autism-linked missense mutation in SHANK3 reveals the modularity of Shank3 function.** *Molecular psychiatry*
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- **The expanding functional roles and signaling mechanisms of adhesion G protein-coupled receptors.** *Annals of the New York Academy of Sciences*
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 - **Electrophysiological, transcriptomic and morphologic profiling of single neurons using Patch-seq.** *Nature biotechnology*
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 - **Emerging Roles of BAI Adhesion-GPCRs in Synapse Development and Plasticity.** *Neural plasticity*
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 - **Molecular Mechanisms of Dendritic Spine Development and Plasticity** *NEURAL PLASTICITY*
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 - **The small GTPases RhoA and Rac1 regulate cerebellar development by controlling cell morphogenesis, migration and foliation.** *Developmental biology*
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Narayanan, A. S., Reyes, S. B., Um, K., McCarty, J. H., Tolias, K. F. 2013; 24 (24): 3857-68
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Schwechter, B., Tolias, K. F. 2013; 6 (6): e27343
 - **RasGRF2 Rac-GEF activity couples NMDA receptor calcium flux to enhanced synaptic transmission.** *Proceedings of the National Academy of Sciences of the United States of America*
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Mulherkar, S., Liu, F., Chen, Q., Narayanan, A., Couvillon, A. D., Shine, H. D., Tolias, K. F. 2013; 8 (6): e67015
 - **The adhesion-GPCR BAI1 regulates synaptogenesis by controlling the recruitment of the Par3/Tiam1 polarity complex to synaptic sites.** *The Journal of neuroscience : the official journal of the Society for Neuroscience*
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