

Matthew Domenic Lycas, Ph.D

Research Specialist, Project Teams / AI Initiative, Janelia Research Campus, HHMI, United States

lycasm@janelia.hhmi.org

Google Scholar: Matthew D. Lycas

ORCID: 0000-0001-8989-8192

Education

- **Ph.D. in Neuroscience**, University of Copenhagen, Department of Neuroscience, Copenhagen, Denmark
August 2017 - April 2021
Thesis Title: The role of dopamine transporter nanodomains: a super resolution microscopy odyssey
Advisors: Prof. Ulrik Gether, Prof. Jakob B. Sørensen, Assistant Prof. Freja Herborg
- **M.Sc. in Pharmaceutical Sciences**, University of Copenhagen, Department of Neuroscience, Copenhagen, Denmark
August 2015 - February 2017
Advisors: Prof. Ulrik Gether, Assistant Prof. Freja Herborg
- **B.A. in Neuroscience**, University of Virginia, Psychiatry and Neurobehavioral Sciences, Charlottesville, Virginia, USA
August 2010 - May 2014
Advisor: Associate Prof. Wendy J. Lynch

Research Experience

- **Research Specialist I**, Janelia Research Campus, HHMI, United States
February 2026 - Present
Project Teams / AI Initiative
Driving the development and large-scale deployment of LICONN (light-microscopy-based connectomics) for expansion-based neural circuit reconstruction across the whole *Drosophila* brain. Leading efforts to industrialize this pipeline to enable high-throughput application across thousands of genetic models, while extending the LICONN framework to zebrafish-based connectomics research.
- **Post-Doctoral Position**, EPFL - Swiss Federal Institute of Technology Lausanne, Lausanne, Switzerland
August 2022 - January 2026
Advisor: Prof. Suliana Manley, Laboratory of Experimental Biophysics

Developed quantitative expansion microscopy methods; manuscript (corresponding author) currently under review at *Nature Communications*. Explored biological questions in mitochondrial research with live STED microscopy and fluorescence lifetime imaging; mitochondrial dynamics research accepted at *Science*.

- **Post-Doctoral Position**, Julius Maximilian University of Würzburg, Würzburg, Germany
August 2021 – August 2022
Advisor: Prof. Markus Sauer, Department of Biotechnology and Biophysics
Pursued neuropharmacology research with fluorescent lifetime imaging of neurons, and explored the combination of single molecule localization microscopy in expanded samples.
- **Graduate Student Researcher**, University of Copenhagen, Copenhagen, Denmark
December 2015 – August 2021
Implemented super resolution techniques to examine pharmacological manipulation of the dopamine transporter
- **Startup Founder – Neurite**, Copenhagen, Denmark
October 2018 – March 2020
Created machine learning based tools for pharmaceutical development, and was contracted to work for local biotech startups in Copenhagen.
- **Post-Baccalaureate Researcher**, National Institute on Drug Abuse NIH, Baltimore, Maryland, USA
August 2014 – August 2015
Advisor: Dr. Carl Lupica, Electrophysiology Research Section
Conducted brain slice electrophysiology experiments studying the impact of synthetic cannabinoids on glutamatergic neurotransmission.
- **Baccalaureate Student Researcher**, University of Virginia, Charlottesville, Virginia, USA
November 2010 – June 2014
Advisor: Associate Prof. Wendy J. Lynch
Performed rodent operant conditioning experiments, stereotaxic surgery, microdialysis, and in vivo neuropharmacology to measure the therapeutic potential of anti-seizure medications in curbing addiction to narcotics.

Publications

*Publications marked with * indicate corresponding authorship.*

1. * **Lycas, M.D.**, Landoni, J.C., Noferi, B., Zimmerli, C.E., Douglass, K.M., Manley, S. (2026). Quantitative Expansion Microscopy for In Situ Estimation of Endogenous Target Abundance. *Manuscript under review at Nature Communications*. *bioRxiv* 2026.01.18.700178. <https://doi.org/10.64898/2026.01.18.700178>
2. Vasylieva, I., Smith, R., Aravind, E., Pless, L.L., He, K., Ling, T., Kozel, J., Puig, S., Kedziora, K.M., Scarlett, J.J., Joseph, P.N., **Lycas, M.D.**, Williams, B.R., Gamble, M.C., Gether,

- U., Logan, R.W., Freyberg, Z., Watson, A.M. (2026). Brain-wide mapping reveals temporal and sexually dimorphic opioid actions. *Communications Biology*. <https://doi.org/10.1038/s42003-026-09730-8>
3. Landoni, J.C., **Lycas, M.D.**, Macuada, J., Stepp, W., Jaccard, R., Obara, C.J., Moore, A.S., Hoffman, D., Lippincott-Schwartz, J., Marshall, W., Sturm, G., Manley, S. (2024). Pearling Drives Mitochondrial DNA Nucleoid Distribution. *Accepted at Science*. *bioRxiv*, 2024.12.21.629917. <https://doi.org/10.1101/2024.12.21.629917>
 4. Ejdrup, A., Dreyer, J.K., **Lycas, M.D.**, Jørgensen, S.H., Robbins, T.W., Dalley, J., Herborg, F., Gether, U. (2026). Computational modelling identifies key determinants of subregion-specific dopamine dynamics in the striatum. *eLife* 14:RP105214. <https://doi.org/10.7554/eLife.105214>
 5. Schmidt, J.H., Herlo, R., Rombach, J., Larsen, A.H., Stoklund, M., Perslev, M., Nielsen, T.T.E., Andersen, K.A., Klein Herenbrink, C., **Lycas, M.D.**, Ejdrup, A.L., Christensen, N.R., Christensen, J.P., Salman, M., Herborg, F., Gether, U., Hauser, A.S., Bassereau, P., Perrais, D., Madsen, K.L. (2025). Membrane curvature association of amphipathic helix 8 drives constitutive endocytosis of GPCRs. *Science Advances*, 11(33):eadv1499. <https://doi.org/10.1126/sciadv.adv1499>
 6. * **Lycas, M.D.**, Morado, D.R., Gether, U., Briggs, J.A.G., Erlendsson, S. (2024). Ultrastructural Dynamics of Dopaminergic Presynaptic Release Sites revealed by Cryo-correlative Light and Electron Microscopy. *Accepted at Journal of Cell Biology*. *bioRxiv*, 2024.04.15.589543.
 7. **Lycas, M.D.**, Manley, S. (2024). DNA-PAINT adaptors make for efficient multiplexing. *Cell Reports Methods*, 4(6):100801. <https://doi.org/10.1016/j.crmeth.2024.100801>
 8. Wen, G., **Lycas, M.D.**, Jia, Y., Leen, V., Sauer, M., Hofkens, J. (2023). Trifunctional linkers enable improved visualization of actin by expansion microscopy. *ACS Nano*, 17(20):20589–20600. <https://doi.org/10.1021/acsnano.3c07510>
 9. Ejdrup, A.L., **Lycas, M.D.**, Herborg, F., Gether, U. (2025). Chapter 11 - Dopamine transporters and the nanoscale organization of the dopamine axon. In S.J. Cragg & M.E. Walton (Eds.), *Handbook of Behavioral Neuroscience*, Vol. 32 (pp. 129–140). Elsevier. ISBN 9780443298677. <https://doi.org/10.1016/B978-0-443-29867-7.00008-6>
 10. Christiansen, L.I., Ventura, G.C., Holmqvist, B., Aasmul-Olsen, K., Lindholm, S.E.H., **Lycas, M.D.**, Mori, Y., Secher, J.B., Burrin, D.G., Thymann, T., Sangild, P.T., Pankratova, S. (2023). Insulin-like growth factor 1 supplementation supports motor coordination and affects myelination in preterm pigs. *Frontiers in Neuroscience*, 17:1205819. <https://doi.org/10.3389/fnins.2023.1205819>
 11. Ejdrup, A.L., Wellbourne-Wood, J., Dreyer, J.K., Gulddammer, N., **Lycas, M.D.**, Gether, U., Hall, B.J., Sørensen, G. (2023). Within-mice comparison of microdialysis and fiber photometry-recorded dopamine biosensor during amphetamine response. *ACS Chemical Neuroscience*, 14(9):1622–1630. <https://doi.org/10.1021/acchemneuro.2c00817>
 12. Jørgensen, S.H., Ejdrup, A.L., **Lycas, M.D.**, Posselt, L.P., Madsen, K.L., Tian, L., Dreyer, J.K., Herborg, F., Sørensen, A.T., Gether, U. (2023). Behavioral encoding across timescales by region-specific dopamine dynamics. *Proceedings of the National Academy of Sciences*, 120(7):e2215230120. <https://doi.org/10.1073/pnas.2215230120>

13. **Lycas, M.D.**, Ejdrup, A.L., Sørensen, A.T., Haahr, N.O., Jørgensen, S.H., Guthrie, D.A., Støier, J.F., Werner, C., Newman, A.H., Sauer, M., Herborg, F., Gether, U. (2022). Nanoscopic dopamine transporter distribution and conformation are inversely regulated by excitatory drive and D2 autoreceptor activity. *Cell Reports*, 40(13):111431. <https://doi.org/10.1016/j.celrep.2022.111431>
14. Baerends, E., Soud, K., Folke, J., Pedersen, A.K., Henmar, S., Konrad, L., **Lycas, M.D.**, Mori, Y., Pakkenberg, B., Woldbye, D.P.D., Dmytriyeva, O., Pankratova, S. (2022). Modeling the early stages of Alzheimer’s disease by administering intracerebroventricular injections of human native amyloid beta oligomers to rats. *Acta Neuropathologica Communications*, 10(1):113. <https://doi.org/10.1186/s40478-022-01417-5>
15. Ejdrup, A.L., **Lycas, M.D.**, Lorenzen, N., Konomi, A., Herborg, F., Madsen, K.L., Gether, U. (2022). A density-based enrichment measure for assessing colocalization in single-molecule localization microscopy data. *Nature Communications*, 13(1):4388. <https://doi.org/10.1038/s41467-022-32064-y>
16. Henriksen, N.L., Hansen, S.H., **Lycas, M.D.**, Pan, X., Eriksen, T., Johansen, L.S., Sprenger, R.R., Ejsing, C.S., Burrin, D.G., Skovgaard, K., Christensen, V.B., Thymann, T., Pankratova, S. (2022). Cholestasis alters brain lipid and bile acid composition and compromises motor function in neonatal piglets. *Physiological Reports*, 10(13):e15368. <https://doi.org/10.14814/phy2.15368>
17. Toschi, C., El-Sayed Hergig, M., Burghi, T., Sell, T., **Lycas, M.D.**, Moazen, P., Huang, L., Gether, U., Robbins, T.W., Dalley, J.W. (2022). Dissociating reward sensitivity and negative urgency effects on impulsivity in the five-choice serial reaction time task. *Brain and Neuroscience Advances*, 6:23982128221102256. <https://doi.org/10.1177/23982128221102256>
18. Andersen, R.C., Schmidt, J.H., Rombach, J., **Lycas, M.D.**, Christensen, N.R., Lund, V.K., Stapleton, D.S., Pedersen, S.S., Olsen, M.A., Stoklund, M., Noes-Holt, G., Nielsen, T.T., Keller, M.P., Jansen, A.M., Herlo, R., Pietropaolo, M., Simonsen, J.B., Kjærulff, O., Holst, B., Attie, A.D., Gether, U., Madsen, K.L. (2022). Coding variants identified in patients with diabetes alter PICK1 BAR domain function in insulin granule biogenesis. *The Journal of Clinical Investigation*, 132(5). <https://doi.org/10.1172/JCI144904>
19. Sørensen, G., Rickhag, M., Leo, D., **Lycas, M.D.**, Ridderstrom, P.H., Weikop, P., Lilja, J.H., Rifès, P., Herborg, F., Woldbye, D., Wörtwein, G., Gainetdinov, R.R., Fink-Jensen, A., Gether, U. (2021). Disruption of the PDZ domain-binding motif of the dopamine transporter uniquely alters nanoscale distribution, dopamine homeostasis, and reward motivation. *Journal of Biological Chemistry*, 297(6):101361. <https://doi.org/10.1016/j.jbc.2021.101361>
20. Herborg, F., Jensen, K.L., Tolstoy, S., Arends, N.V., Posselt, L.P., Shekar, A., Aguilar, J.I., Lund, V.K., Erreger, K., Rickhag, M., **Lycas, M.D.**, Lonsdale, M.N., Rahbek-Clemmensen, T., Sørensen, A.T., Newman, A.H., Løkkegaard, A., Kjærulff, O., Werge, T., Møller, L.B., Matthies, H.J., Galli, A., Hjermind, L.E., Gether, U. (2021). Identifying dominant-negative actions of a dopamine transporter variant in patients with parkinsonism and neuropsychiatric disease. *JCI Insight*, 6(18). <https://doi.org/10.1172/jci.insight.151496>
21. Lund, V.K., **Lycas, M.D.**, Schack, A., Andersen, R.C., Gether, U., Kjaerulff, O. (2021). Rab2 drives axonal transport of dense core vesicles and lysosomal organelles. *Cell Reports*, 35(2):108973. <https://doi.org/10.1016/j.celrep.2021.108973>

22. Ducrot, C., Bourque, M.J., Delmas, C.V.L., Racine, A.S., Guadarrama Bello, D., Delignat-Lavaud, B., **Lycas, M.D.**, Fallon, A., Michaud-Tardif, C., Burke Nanni, S., Herborg, F., Gether, U., Nanci, A., Takahashi, H., Parent, M., Trudeau, L.E. (2021). Dopaminergic neurons establish a distinctive axonal arbor with a majority of non-synaptic terminals. *The FASEB Journal*, 35(8):e21791. <https://doi.org/10.1096/fj.202100201RR>
23. Guthrie, D.A., Klein Herenbrink, C., **Lycas, M.D.**, Ku, T., Bonifazi, A., DeVree, B.T., Mathiasen, S., Javitch, J.A., Grimm, J.B., Lavis, L., Gether, U., Newman, A.H. (2020). Novel Fluorescent Ligands Enable Single-Molecule Localization Microscopy of the Dopamine Transporter. *ACS Chemical Neuroscience*, 11(20):3288–3300. <https://doi.org/10.1021/acscchemneuro.0c00397>
24. Herlo, R., Lund, V.K., **Lycas, M.D.**, Jansen, A.M., Khelashvili, G., Andersen, R.C., Bhatia, V., Pedersen, T.S., Albornoz, P.B.C., Johnner, N., Ammendrup-Johnsen, I., Christensen, N.R., Erlendsson, S., Stoklund, M., Larsen, J.B., Weinstein, H., Kjærulff, O., Stamou, D., Gether, U., Madsen, K.L. (2018). An amphipathic helix directs cellular membrane curvature sensing and function of the BAR domain protein PICK1. *Cell Reports*, 23(7):2056–2069. <https://doi.org/10.1016/j.celrep.2018.04.074>
25. Rahbek-Clemmensen, T., **Lycas, M.D.**, Erlendsson, S., Eriksen, J., Apuschkin, M., Vilhardt, F., Jørgensen, T.N., Hansen, F.H., Gether, U. (2017). Super-resolution microscopy reveals functional organization of dopamine transporters into cholesterol and neuronal activity-dependent nanodomains. *Nature Communications*, 8(1):740. <https://doi.org/10.1038/s41467-017-00790-3>
26. Hoffman, A.F., **Lycas, M.D.**, Kaczmarzyk, J.R., Spivak, C.E., Baumann, M.H., Lupica, C.R. (2017). Disruption of hippocampal synaptic transmission and long-term potentiation by psychoactive synthetic cannabinoid ‘Spice’ compounds: comparison with delta-9-tetrahydrocannabinol. *Addiction Biology*, 22(2):390–399. <https://doi.org/10.1111/adb.12334>
27. Sanchez, V., **Lycas, M.D.**, Lynch, W.J., Brunzell, D.H. (2015). Wheel running exercise attenuates vulnerability to self-administer nicotine in rats. *Drug and Alcohol Dependence*, 156:193–198. <https://doi.org/10.1016/j.drugalcdep.2015.09.022>
28. Ramoã, C.P., Doyle, S.E., **Lycas, M.D.**, Chernau, A.K., Lynch, W.J. (2014). Diminished role of dopamine D1-receptor signaling with the development of an addicted phenotype in rats. *Biological Psychiatry*, 76(1):8–14. <https://doi.org/10.1016/j.biopsych.2013.09.028>
29. Moore, C.F., **Lycas, M.D.**, Bond, C.W., Johnson, B.A., Lynch, W.J. (2014). Acute and chronic administration of a low-dose combination of topiramate and ondansetron reduces ethanol’s reinforcing effects in male alcohol preferring (P) rats. *Experimental and Clinical Psychopharmacology*, 22(1):35–42. <https://doi.org/10.1037/a0035215>

Prizes, Awards, Fellowships

- Poster prize at Göttingen Expansion Forum *2026*
- Poster prize at EMBO Workshop In situ Structural Biology *2023*
- Travel award, SMLMS conference *2019*

- Lundbeck Running costs grant (Co-Applicant) *2018*
- Lundbeck Ph.D Fellowship grant (Main Applicant) *2017*
- Harrison Undergraduate Research award *2013*

Approved Research Projects

- Lundbeckfonden Approved research grant: Nanoscale architecture of presynaptic dopamine terminals (1,575,000 DKK)
Reference: R230-2016-3154 (Main Applicant)
- Lundbeckfonden Approved research grant: Nanoscale architecture of presynaptic dopamine terminals (500,000 DKK)
Reference: R266-2017-4331 (Co-applicant)

Teaching Experience

- Physiology: Modern Cell Biology Using Microscopic, Biochemical and Computational Approaches 2024, Marine Biological Laboratory
Teaching assistant
June-July 2024 and 2025
- Quantitative Imaging: From Acquisition to Analysis 2024, Cold Spring Harbor
Teaching assistant and instructor of Expansion Microscopy lessons
April 2024 and 2025
- M.Sc. in Neuroscience, University of Copenhagen
Lecture for the Novel Technologies Course
July 2020, 2021, 2022, 2023
- M.Sc. in Human Biology, University of Copenhagen
Experimental work instruction in the Molecular and Biology Genetics Course
October 2017, 2018, 2019, 2020

Mentoring Experience

- Supervised PhDs: Berna Durmas (EPFL), Josefa Macuada (EPFL), Aske L. Ejdrup (University of Copenhagen), Danush Taban (University of Würzburg)
- Supervised MSc: Iolene Bouzdine (EPFL), Aske L. Ejdrup (University of Copenhagen), Nicolai O. Haahr (University of Copenhagen)

Active Memberships in Scientific Societies and Outreach

- Society for Neuroscience (SFN) since 2017
- Reviewer for Nature Methods (1× in 2026)
- Reviewer for Nature Nanotechnology (1× in 2025)
- Reviewer for Nature Cell Biology (1× in 2025)
- Reviewer for STAR Protocols (4× in 2025, 2× in 2024)
- Reviewer for Nature Communications (1× in 2023)
- Volunteer for local biology week *2023*

Core Competencies

- **Advanced Imaging Techniques:** Live STED microscopy, Quantitative Expansion Microscopy, dSTORM, Single Particle Tracking PALM, iSIM, SIM, Cryo-CLEM, Fluorescence Lifetime Imaging
- **Mitochondrial Biology:** Cristae dynamics, respiratory chain complexes, mitochondrial ultrastructure, pearling phenomena, mtDNA nucleoid organization
- **Quantitative Analysis:** Computational image analysis, correlation methods, single-molecule localization, statistical approaches for molecular counting
- **Platform and Team Leadership:** Cross-functional team management, mentorship of PhD and MSc students, collaborative research initiative development
- **Neuronal Culture Expertise:** Primary dopaminergic, hippocampal, and cortical neuron culturing, viral transduction techniques, genetic manipulation, functional assays in neuronal systems

Major Scientific Achievements

- **Quantitative Expansion Microscopy and live STED for Ultrastructural Dynamics:** Led a pioneering initiative at EPFL using live STED imaging to study the role of cristae in the pearling of mitochondria – this work has been accepted at *Science*. Separately developed quantitative expansion microscopy as a generalized method to estimate the abundance of endogenous protein targets with super-resolution spatial information; this manuscript, my second corresponding authorship, is currently under review at *Nature Communications*. Through these

complementary approaches, I developed imaging pipelines applicable to diverse cell biology targets within the life sciences, including centrioles and intracellular immunity systems through cGAS. The expansion microscopy methodology paired with STED enables quantification of endogenous targets across the cell with approximately 10 nm spatial resolution.

- **The Role of Dopamine Transporter Nanodomains:** The main project of my graduate scientific research was to examine the role of dopamine transporter nanodomains on dopaminergic neurons. This involved the conception of the work, the design of the project, neuronal cell culturing, viral construct production, pharmacology, single molecule localization microscopy, brain slice imaging, expansion microscopy, single particle tracking, python coding, writing the manuscripts, and many other disciplines. Through this work, I presented the findings at conferences around the world, was the main and co-applicant for grants to fund this research, and together with my advisors and colleagues published research papers in *Nature Communications*, *Cell Reports*, and other prestigious journals.
- **Cryo-CLEM Tomography of Dopaminergic Neurons:** Driven by my interest in the ultrastructure of dopamine synapses, I collaborated with Simon Erlendsson who had just returned to Copenhagen from a postdoc in Prof John A.G. Briggs' group, then at MRC Laboratory of Molecular Biology. Together, we devised an improved way to grow neurons on the surfaces used for cryo-EM tomography that allowed for targeted imaging of synapses, utilized cryo-CLEM to identify dopaminergic synapses, and imaged the samples with multiple electron microscopes across facilities in Denmark and Sweden through the CryoNet network to capture angstrom resolution images of dopaminergic synapses. I presented this publicly at the EMBL In situ structural biology conference and won the poster prize. This manuscript, my first corresponding authorship, has been accepted at the *Journal of Cell Biology*. Through this research, we showed we can use subtomogram averaging to capture in situ protein structure in synapses as well as pharmacologically induced changes.