Shahar Bracha, PhD

Address: Somerville, MA | Email: shaharbr@mit.edu

Research interests: I believe there is immense untapped potential in bringing together evolutionary biology, synthetic biology and bioengineering. This drives my research in two main directions: (1) developing technologies and experimental approaches to explore and harness the vast diversity of molecular mechanisms found in nature, to identify and engineer molecular tools that address technological challenges in neuroscience and human health; and (2) applying evolutionary principles to enhance and create new approaches to engineering biology (which is more complex and beautifully messier than other engineering systems). My primary focus is on evolutionarily informed methods for protein engineering, machine learning-assisted modeling of sequence-function landscapes, methods for cellular- and millisecond-resolution optical recording of brain activity, and applications of whole-brain voltage imaging for studying neurological diseases in zebrafish.

Education and training

Postdoctoral Associate	**Massachusetts Institute of Technology (MIT)** Mentor: Prof. Ed Boyden	June 2021 - Present
Ph.D. Neuroscience	**Tel Aviv University** Thesis title: "*Engineering Toxoplasma gondii for delivery of therapeutic proteins to the central nervous system*". Mentor: Prof. Oded Rechavi. Visiting researcher at the University of Glasgow, UK (joint mentorship by Prof. Lilach Sheiner).	Oct 2013 - June 2020
B.Sc. Biology	**Tel Aviv University** *Magna Cum Laude*	Oct 2010 - Sept 2013

Publications and preprints

- **Library transgenesis in zebrafish through delayed site-specific mosaic integration for in vivo pooled screening of transgenes.** Shahar Bracha, Adam Amsterdam, Yasu Xu, Liyam Chitayat, Anubhav Sinha, Edward Boyden. *bioRxiv (2026).*
- **Screening channelrhodopsins using robotic intracellular electrophysiology and single cell sequencing.** Samuel Ehrlich, Alexandra D VandeLoo, Mohamed Badawy, Mercedes M Gonzalez, Max Stockslager, Aimei Yang, Sapna Sinha, Shahar Bracha, Demian Park, Benjamin Magondu, Bo Yang, Edward S Boyden, Craig R Forest. *Journal of Neuroscience Methods (2025)*.
- **Engineering Toxoplasma gondii secretion systems for intracellular delivery of multiple large therapeutic proteins to neurons**. Shahar Bracha, Hannah J. Johnson, Nicole A. Pranckevicius, Francesca Catto, Athena E. Economides, Sergey Litvinov, Karoliina Hassi, Marco Tullio Rigoli, Cristina Cheroni, Matteo Bonfanti, Alessia Valenti, Sarah Stucchi, Shruti Attreya, Paul D. Ross, Daniel Walsh, Stuart Cobb, Petros Koumoutsakos, Nicolò Caporale, Giuseppe Testa, Adriano Aguzzi, Anita A. Koshy, Lilach Sheiner, Oded Rechavi. *Nature Microbiology (2024).*
- **Improving protein optimization with smoothed fitness landscapes**. Andrew Kirjner, Jason Yim, Raman Samusevich, Shahar Bracha, Tommi S. Jaakkola, Regina Barzilay, Ila R Fiete. *ICLR (2024).*
- **Neuronal Small RNAs Control Behavior Transgenerationally**. Rachel Posner, Itai Antoine Toker, Olga Antonova, Ekaterina Star, Sarit Anava, Eran Azmon, Michael Hendricks, Shahar Bracha, Hila Gingold, Oded Rechavi. *Cell (2019).*

Patents

- Oded Rechavi, Shahar Bracha, Lilach Sheiner (2017). Engineered parasites for delivering protein to the central nervous system (cns). US Patent. 18/814,678

Conference presentations and seminars

Talks:

"Training machine learning models on data from direct in vivo screening for data-guided generation of optimized genetic tools." Machine Learning in Biology Working Group seminar, MIT, March 24, 2026.

"Library transgenesis for in vivo pooled screening using delayed site-specific integration." Cold Spring Harbor Laboratory (CSHL) Zebrafish Neurobiology meeting, November 19-22, 2025.

"Harnessing nature's solution for drug delivery to the brain". Symbiogenesis seminar series, May 21, 2025.

"Engineering a brain parasite into a tool for therapeutic protein delivery to the brain". Ragon Institute seminar, August 15, 2024.

"Engineering serendipity: the BioNet collaborative network for mining molecular tools from the natural world". Yang-Tan Research Centers Retreat, June 3, 2022.

"Harnessing nature's solution for drug delivery to the brain". Teva's national bioinnovators forum, February 23, 2021.

"Two Extreme Explosions of H-rich Stars". Annual meeting of the Israel Physical Society (IPS), February 17, 2020..

"Using Toxoplasma gondii as a vector for therapeutic protein delivery to the CNS". ToxoUK, November 1-2, 2018.

"Using Toxoplasma gondii as a vector for therapeutic protein delivery to the CNS". Biology of Host-Parasite Interactions Gordon Research Conference and Gordon Research Seminar, June 9-15, 2018.

Posters:

"New strategies for molecular tool development using machine learning and direct in vivo screening". Yang-Tan Research Centers Retreat, January 13-14, 2026.

"Machine learning-enhanced development of voltage indicators for high resolution neural recording across the brain". Patrick J. McGovern Travel & Technology Awards, April 10, 2025.

"Improving protein optimization with smoothed fitness landscapes". The International Conference on Learning Representations (ICLR), May 7-11, 2024.

"Experimental large scale phenotyping of proteins for machine learning-guided sequence-function modeling and design". Protein Engineering Gordon Research Conference: Expanding the Boundaries of Protein Engineering, July 23-28, 2023.

"BLAST-in-a-Tube: Implementing homology search with physics rather than *in silico* to capture homologs directly from environmental metagenomic extracts". Applied and Environmental Microbiology Gordon Research Conference: Writing the Microbial Constitution, July 16-21, 2023.

"Engineering Toxoplasma gondii as a tool for intracellular delivery of proteins to the central nervous system". International Toxoplasma Congress, May 22-26, 2022.

"SN 2018hmx: An Extreme Type II SN with High Nickel Mass". The extragalactic explosive Universe: the new era of transient surveys and data-driven discovery, September 16-19, 2019

"Can we make an enemy a friend? Engineering Toxoplasma gondii as a vector for delivering therapeutic proteins to the brain". Infectious Disease Research Initiative Scotland Meeting, March 6-7, 2019

"Engineering Parasites for the Delivery of Therapeutic Proteins to the CNS". 8th ILANIT / FISEB, February 20-23, 2017.

"The role of Clara cell senescence in the pathogenic mechanism of COPD". SENS 6th conference for ageing and regenerative medicine, 3-7 September, 2013.

Grants and fellowships

Y. Eva Tan Postdoctoral fellowship	2023-2025
International Rett Syndrome Foundation (IRSF) Basic Research Grant: “Transgenic T. gondii as a platform for MeCP2 protein delivery to the CNS” (co-written with Dr. Lilach Sheiner, Prof. Stuart Cobb and Prof. Oded Rechavi).	2018-2019
Nadal Colton Applied Research Grant, The Miles Nadal institute for Technological Entrepreneurship: “Transgenic parasites as a platform for delivering proteins to the CNS” (co-written with Prof. Oded Rechavi).	2015-2017

Awards

Patrick J. McGovern Travel & Technology Award	2025
The Daniel Turnberg Research Exchange Award, Academy of Medical Sciences, UK	2019
Ph.D. Award, The Prajs-Drimmer Institute for the Development of Anti-Degenerative Drugs	2018
The Joan and Jaime Constantiner Institute Award	2018
ToxoUK Travel Fellowship	2018
Sagol School of Neuroscience Travel Award	2016
The Naomi Foundation Global Research & Training Award	2014
Scholarship for the SENS research internship program, Weizmann Institute of Science	2013
Scholarship for the Amos De-Shalit program, Weizmann Institute of Science	2012

Teaching experience

Teaching Assistant, MIT. Principles of Neuroengineering. Fall 2024, 2025

Academic service

Reviewer, International Conference on Learning Representations (ICLR) Workshop on Generative and Experimental Perspectives for Biomolecular Design: 2024, 2025, 2026.

Reviewer, STAR Protocols: 2025

Reviewer, Homeworld Collective garden grants: 2023