Douglas J. Blackiston

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Harvard Wyss Institute for Biologically Inspired Engineering
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POSITIONS AND EDUCATION

2019 – Present *Visiting Scholar, Principal Investigator*
Wyss Institute for Biologically Inspired Engineering
Harvard University

2018 – Present *Principal Scientist, Principal Investigator*
Allen Discovery Center, Department of Biology
Tufts University

2015 – 2018 *Senior Scientist*
Allen Discovery Center, Department of Biology
Tufts University

2012 – 2014 *Post-Doctoral Fellow*
Department of Biology
Tufts University

2007 – 2011 *Post-Doctoral Fellow*
The Forsyth Institute, Harvard Medical School
Center for Regenerative and Developmental Biology

2002 – 2007 *Ph.D., Biology*
Georgetown University, Washington DC
Dr. Martha Weiss and Dr. Elena Silva Casey, Advisors.
Thesis: Learning and memory in larval and adult Lepidoptera

2002 *Bachelor of Science, Biological Sciences (Minor: Education)*
McDaniel College, Westminster, MD
Howard Hughes Research Fellow

PUBLICATIONS

25. **Blackiston, D**., Kriegman, S., Bongard, J., & Levin, M. (2023). Biological Robots: Perspectives on an Emerging Interdisciplinary Field. *Soft Robotics*. 10.1089/soro.2022.0142.

24. Kudithipudi, D., Anguilar-Simon, M., Babb, J., Bazhenov, M., **Blackiston, D**.,… et. al. (+38 others). (2022). Biological underpinnings for lifelong learning machines. *Nature Machine Intelligence*. 4 (3), 196-210.

23. **Kriegman, S. *, Blackiston, D**. *, Levin, M., Bongard, J. (2021). Kinematic self-replication in reconfigurable organisms. *Proceedings of the National Academy of Sciences*. 118 (49).
***co-first author**

22. **Blackiston, D**., Lederer, E., Kriegman, S., Bongard, J., Levin, M. (2021). A cellular platform for the development of synthetic living machines. *Science Robotics* 6.52 (2021).

21**. Kriegman, S. *, Blackiston, D**. *, Levin, M., Bongard, J. (2020). A scalable pipeline for designing reconfigurable organisms. *Proceedings of the National Academy of Sciences*. (4) 1853-1859.
***co-first author**

20. **Blackiston, D**., Vien, K., Levin, M. (2018). Serotonergic stimulation induces nerve growth and promotes visual learning following posterior eye grafts in Xenopus tadpoles. *Nature Regenerative Medicine*. 2 (1),8.

19. **Blackiston, D.**, Levin, M. (2017). Reversals of bodies, brain, and behavior: quantitative analysis of laterality and its disturbance in model species. *Neuromethods*. 667-694.

18. Morokuma, J., Durant, F., Williams, K.B., Finkelstein, J.M, **Blackiston, D**., Clements, T., Reed, D., Roberts, M., Jain, M., Kimel, K., Trauger, S., Wolfe, B., Levin, M. (2017). Planarian regeneration in space: persistent anatomical, behavioral, and bacteriological changes induced by space travel. *Regeneration*. 4 (2), 85-102.

17. Rothman, G.*, Blackiston, D.*, Levin, M. (2016). Color and intensity discrimination in *Xenopus laevis* tadpoles. *Animal Cognition*. 19(5): 911-919
***co-first author with mentored undergraduate**

16. **Blackiston, D.**, Shomrat, T., Levin, M. (2015). The stability of memories during brain remodeling: a perspective. *Communicative and Integrative Biology*. 8(5): e1073424

15. Lobikin, M., Lobo, D., **Blackiston, D.**, Martynuik, C.J., Tkachenko, E., Levin, M. (2015). Serotonergic regulation of melanocyte conversion: a bioelectric network explains stochastic all-or-none hyperpigmentation. *Science Signaling*. 8(397): ra99.

14. **Blackiston, D.**, Anderson, G., Rahman, N., Bieck, C., Levin, M. (2015). A novel method for inducing nerve growth via modulation of host resting potential: gap junction-mediated and serotonergic signaling mechanisms. *Neurotherapeutics*. 12(1): 170-184.

13. Vandenberg, L., **Blackiston, D.**, Rea, A., Dore, T., Levin, M. (2014) Left-right *patterning* in Xenopus conjoined twin embryos requires serotonin signaling and gap junctions. *International Journal of Developmental Biology*. doi: 10.1387/ijdb.140215ml.

12. **Blackiston, D.**, Levin, M. (2013). Inversion of left-right asymmetry alters performance of *Xenopus* tadpoles in non-lateralized cognitive tasks. *Animal Behaviour*. 86(2): 459-466.

11. **Blackiston, D.**, Levin, M. (2013). Ectopic eyes outside the head in *Xenopus* tadpoles provide sensory data for light-mediated learning. *Journal of Experimental Biology*. 216(6): 1031-1040.

10. Pai, V.P., Vandenberg, L.N**., Blackiston, D.**, Levin, M. (2012). Neurally derived tissues in *Xenopus laevis* embryos exhibit a consistent bioelectrical left-right asymmetry. *Stem Cells International*. 2012:353491

9. **Blackiston, D.**, Levin, M. (2011). Aversive training methods in *Xenopus laevis*: general principles. *Cold Spring Harbor Protocols*. doi 10.1101/pdb.top068338.

8. **Blackiston, D.**, Shomrat, T., Granta, C., Levin, M. (2011). A second-generation device for automated training and quantitative behavior analyses of molecularly tractable model organisms. *PLoS ONE*. 5(12):e14370.

7. **Blackiston, D.**, Briscoe, A., Weiss, M. (2011). Color vision and learning in the monarch butterfly, *Danaus plexippus* (Nymphalidae). *Journal of Experimental Biology*. 214(3): 509-520.

6. **Blackiston, D.**, Adams, D., Lemire, J., Levin, M. (2010). Transmembrane potential of GlyCl-expressing instructor cells induces a neoplastic-like conversion of melanocytes via a serotonergic pathway. *Disease Models and Mechanisms*. 4(1):67-85.

5. **Blackiston, D.**, Vandenberg, L., Levin, M. (2010). High throughput *Xenopus laevis* immunohistochemistry using agarose sections. *Cold Spring Harbor Protocols*. doi: 10.1101/pdb.prot5532.

4. **Blackiston, D.**, McLaughlin, K., Levin, M. (2009). Bioelectric controls of cell proliferation: Ion channels, membrane voltage, and the cell cycle. *Cell Cycle* 8(21): 3519-3528

3. Morokuma, J., **Blackiston, D.**, Adams, D., Seebohm, G., Trimmer, B., Levin, M. (2008). Modulation of KCNQ1 and KCNE1 K+ channel function induces a neoplastic phenotype in melanocytes. *Proceedings of the National Academy of Sciences.* 105(43):16608-13

2. **Blackiston, D.**, Silva Casey, E., Weiss, M. (2008). Persistence of memory through metamorphosis in *Manduca sexta*. *PLoS ONE*. 3(3): e1736

1. Morokuma, J., **Blackiston, D.**, Levin, M. (2008). KCNQ1 and KCNE1 K+ channel components are involved in early left-right patterning in *Xenopus laevis* embryos. *Cellular Physiology and Biochemistry*. 21(5-6):357-72.

RESEARCH SUPPORT

DoD (RDT&E), Network C3I, (BAA CRREL-23-0001), 2023-2027
J. Bongard, D. Blackiston, M Levin, CRREL. *Biological Sensors for Remote Environments*
Role: Co-Principal Investigator
Total Funds: $8,448,485

Sloan Foundation Matter to Life (G-2021-16495) 2022-2024
D. Inber, D. Blackiston, J. Bongard, M. Levin, W. Shih, W. Wong, P. Yin. *Principles of molecular and cellular self-organization*
Role: Co-Principal Investigator (senior personnel phase I, Co-I phase II)
Total Funds: $1,500,000

Berggruen Institute, 2023-2024
D. Blackiston & C. Sinders. *Human/Embodied Machine Interactions (interactive program development)*

Role: Principal Investigator
Total Funds: $36,500

Copernicus Science Center in Warsaw (944/KEI/2022/E MTA), 2023
D. Blackiston. *Human 2.0 Exhibition: The Future is Today*
Role: Principal Investigator
Total Funds: $4,851

Diverse Intelligences Initiative (TWCF0552), 2021-2023
D. Blackiston. *Engineered behavior and swarm dynamics in synthetic multicellular systems*. *Funding transferred due to COI.*
Role: Principal Investigator
Total Funds: $234,000

DARPA L2M Program, 2018-2022
M. Levin, J. Bongard., S. Walker. *Somatic computation via bioelectricity for novel life-time learning machines*
Role: Co-Author, Senior Personnel
Total Funds: $1,900,000

The Paul G. Allen Frontiers Group, 2015-2020
Reading and writing the morphogenetic code
Role: Primary Scientist, Participant Only
Total Funds: $10,000,000

NIH R01 Research Project Grant (5R01MH081842-02), 2010
M. Levin. *Automated analysis of learning and memory for neuro-developmental studies*.
Role: Co-Author, Senior Personnel
Total Funds: $1,151,250

NIH F32 Individual National Research Service Award (1F32NS060654-01A1), 2009
D. Blackiston. *Effects of CNS asymmetry inversion on zebrafish and Xenopus learning and memory*.
Role: Principal Investigator
Total Funds: $200,370

NIH T32 Institutional National Research Service Award (5T32DE007327-09), 2007
D. Blackiston. *Depolarization of membrane potential induces a neoplastic phenotype in melanocytes*
Role: Principal Investigator
Total Funds: $187,410

PATENTS

1. Engineered Multicellular Organisms. US No. 63/136,564. International No. PCT/US2021/013105
2. Engineered Multicellular Organisms and the Kinematic Self-Replication Thereof. App. No. 17/647,847

TEACHING EXPERIENCE

Independent Course Instructor, Tufts University

BIO52: Experiments in Cell Biology (14 students)

Topics: Yeast genetics/cell biology, developmental biology, cell physiology
Course evaluations (1-5 scale, poor-excellent):

Accomplishing Objectives: 4.71 (**Excellent**)	Use of Time: 4.71 (**Excellent**)
Instructors Organization: 4.57 (**Excellent**)	Explaining Ideas: 4.71 (**Excellent**),
Timeliness of Feedback: 4.57 (**Excellent**)	Usefulness of Feedback: 4.29 (**Very Good**)
Communication: 4.71 (**Excellent**)	Overall Quality: 4.57 (**Excellent**)

BIO196: Investigations in Cell and Developmental Biology (16 students)
Topics: Stem cell biology, bio-hybrid machines, biological modeling/simulation, bioethics
Course evaluations (1-5 scale, poor-excellent):

Accomplishing objectives: 4.75 (**Excellent**)	Use of Time: 4.69 (**Excellent**)
Out of Class Activities: 4.81 (**Excellent**)	Course Interest: 4.81 (**Excellent**)
Overall Quality: 4.78 (**Excellent**)	

Team Taught Course Instructor, Tufts University

BIO184: Special Topics in Developmental Biology (14 students,)
Roles: Laboratory design and prep, assessments, interactive demos, live cell/organism imaging, introduction to experimental design
Topics: Role of cellular physiology in development
Laboratories in motion: see science in action
Quantifying learning and memory in aquatic vertebrates
Melanocyte development and migration in *Xenopus laevis*
Introduction to biostatistics: non-parametric and parametric analysis

Teaching Assistant, Georgetown University
BIOL373: Developmental Biology (25 students)
BIOL375: Plant Animal Interactions (20 students)
BIOL104: Foundations in Biology (175 students)

Education Team Member – Reducing Attrition Among Minority Biology Majors
Georgetown team member at **Science Education for New Civic Engagements** (SENCER) summer institute (2003). Investigated the attrition of minority scholars in Georgetown University's Biology major. Developed a new onboarding program, enhanced existing mentorship opportunities, developed tracking statistics for minority scholars, worked with collaborators at Howard University, and performed outreach with local D.C. area high schools.

Public School Teaching, Secondary Education
Westminster High School, Maryland, 2001 – co-instructed freshman chemistry under faculty supervision
Westminster Middle School, Maryland, 2001 – independently taught two sections of 7th grade biology

STUDENT MENTORING
Max Rubenstein, HS student, class of 2024, FLHS Research Program – Effect of buoyancy on developing epidermis self-organization
Longan Su, Junior 2022 – Development of multi-ciliated cells in 2d and 3d culture
Melanie Chien, Senior Thesis 2021 – Self-assembly of multi-ciliated cells in developing *Xenopus* ectoderm.
Emma Lederer, Research Technician 2020 – Leveraging *Xenopus* tissues to develop biomachines
- published, first author on manuscript

Daniel Lukason, Graduate Student 2019 – Central nervous system repair in *Xenopus* embryos. Served as a committee member and comprehensive exam reviewer
Sajani Clerk, Sophomore 2018 - Regeneration of optic nerve following mechanical damage and light induced retinal toxicity
Lauren Clore, Sophomore 2018 - Behavior and information processing in engineered tissues
Khanh Vein, Sophomore 2015 – The effects of embryonic SSRI exposure on vertebrate cognition
- published, co-author on manuscript
Dylan Murphy, Senior 2015 – Bioelectric control of muscle regeneration in *Xenopus laevis*
Gabriel Rothman, Junior 2014 – Memory retention and extinction in *Xenopus* tadpoles
- published, first author on manuscript
Nikita Rahman, Senior 2013 – Role of embryonic serotonin on axon guidance
- published, co-author on manuscript
Clara Bieck, undergraduate 2010-2013 – Role of bioelectricity in eye innervation
- published, co-author on manuscript
Nidhi Chillara, Junior 2013 – Associative learning in planarian flatworms
Mary Rose Branch, High School Student 2010-2012 – Regeneration and learning in axolotls
Sarah Carpenter, Senior 2011 – Motion tracking algorithms and data analysis
Garrett Friedman, Sophomore 2010 – Eye regeneration in *Xenopus laevis* embryos
Rebecca DiBiasi, Sophomore 2010 – Visual learning in *Xenopus* tadpoles
Ashley Amick, Senior Thesis 2006 – Appetitive learning in *Manduca sexta*
Selected as one of five students for a department-wide seminar, passed with distinction

AWARDS

2024 Polaris Dawn Biological Payload (shuttle mission)
2023 Museum Exhibit, Copernicus Science Centre “Human 2.0”
2023 Visions of the Wyss Award Winner
2022 Outstanding Paper of the Year, ALIFE
2022 Museum Exhibit, CCCB Barcelona “BRAINS”
2022 Museum Exhibit, MARTa Herford “Organic and Non-organic Lifeforms”
2021 Cozzarelli Prize Recipient – Awarded by the National Academy of Sciences for the most impactful research in engineering and applied sciences
2021 Altmetric top 100, 3.4million entries
2021 Outstanding Paper of the Year Award by The International Society for Artificial Life
2020 Top 10 most influential BioTech Projects, Project Management Institute
2020 Museum Exhibit, Design Museum of London – Beazley Designs of the Year
2020 New York Times – Science Frontpage Feature
2019 Wyss Institute Technology and Research Award Winner
2016 Tufts Vision Scientist, Tufts Medical School
2013 Best Scientific Talk Award, SDB Northeast Meeting
2009 NIH F32 Ruth L. Kirschstein National Research Service Award, Tufts University
2007 NIH T32 Training Grant Recipient, Forsyth Institute, Harvard University
2006 Outstanding Graduate Student in Biology Award, Georgetown University
2006 Runner-up, Best Student Poster SDB National Meeting
2005 National Denali Award Recipient
2005 Best Student Talk, Lepidopterists Society National Meeting
2004 Graduate School Assistantship, Georgetown University
2003 NSF Graduate Research Fellowship Honorary Mention
2002 Howard Hughes Research Fellow
1998 Rotary Scholarship

INVITED TALKS AND CONFERENCE PRESENTATIONS

2024 **Kavli Frontiers of Science Symposium, National Academy of Sciences**. Irvine, CA. Computer designed living systems: living robots or organisms?

2023 **Keynote Speaker. Boston College Biology Retreat**. Portsmouth, NH. Modular organisms: the plasticity of biological form.

2023 **Materials Research Society**. Boston, MA. Modular biomachines built from amphibian stem cells.

2023 **Keynote speaker. Berggruen Institute**, Academy of Arts and Sciences, Cambridge MA. The futures of life.

2022 **Elmira College Lecture Series in the Sciences**, Invited Speaker. Elmira, NY. Using A.I. and developmental biology to engineer biological machines.

2022 **Materials Research Society**. Boston, MA. Computer designed organisms built from embryonic amphibian cells.

2022 **Geneva Science and Diplomacy Anticipator (GESDA)**. Geneva, Switzerland. Science breakthrough radar.

2021 **Society for Developmental Biology**. Virtual Meeting. Computer designed organisms built from embryonic amphibian cells.

2020 **Massachusetts Life Science Innovations**. Boston, MA (virtual meeting). Living machines built from amphibian stem cells.

2020 **Society for Developmental Biology**. Chicago, IL (virtual meeting). Computer designed living machines built from amphibian stem cells.

2019 **Electronics Resurgence Initiative Summit, DARPA** P.I. Meeting. Invited speaker. Detroit, MI. A scalable pipeline for designing reconfigurable lifeforms.

2019 **Society for Developmental Biology**. Boston, MA. Exploring the brain-body interface: animals with ectopic eyes as models for CNS plasticity, development, and regenerative medicine.

2018 **DARPA Lifetime Learning Machines (L2M)** P.I. Meeting, Invited speaker. Washington, DC. Control of patterning and behavior *of in vitro* cellular automata.

2016 **Society for Developmental Biology**. Boston, MA. Serotonergic pathways and membrane potential promotes innervation of eye grafts in *Xenopus* tadpoles.

2016 **Tufts University Medical School**, Invited seminar speaker. Boston, MA. A novel method for inducing nerve growth and innervation control: serotonergic signaling mechanisms.

2015 **University of Massachusetts Amherst**, Invited Seminar Speaker. Amherst, MA. Exploring the cognitive effects of CNS alterations in *Xenopus* tadpoles.

2014 **McDaniel College**, Invited Seminar Speaker. Westminster, MD. Coming full circle, research from the perspective of a liberal arts background.

2013 **Society for Developmental Biology**, Northeast. Woods Hole, MA. Plasticity of the brain-body interface: ectopic eyes placed onto tadpole tails confer functional vision.

2012 **Elmira University**, Invited Seminar Speaker. Elmira, NY. Plasticity of the vertebrate nervous system.

2011 **Society for Developmental Biology**. Chicago, IL. Automated training and quantitative behavior analysis of molecularly tractable model organisms.

2010 **Society for Developmental Biology**. Albuquerque, NM. Transmembrane voltage gradient in GlyR-expressing niche cells controls behavior of neural crest derivatives *in vivo*.

2009 **Society for Developmental Biology**. San Francisco, CA. Control of embryonic stem cell proliferation and migration can be controlled in vivo by pharmacological modulation of endogenous ion channels.

2009 **NIH NIDCR Annual Research Training Session**, Invited Seminar Speaker. Washington, DC. Control of embryonic stem cell proliferation and migration can be controlled in vivo by pharmacological modulation of endogenous ion channels.

2006 **Society for Developmental Biology**. Ann Arbor, MI. Memory through metamorphosis in *Manduca sexta*.
2005 **Lepidopterist Society**. Sierra Vista, AZ. Can a caterpillar learn something a moth will remember?
2005 **Society for Developmental Biology**. San Francisco, CA. Effect of larval conditioning on adult *Manduca sexta* behavior.
2005 **NIH Zfig**, Invited Speaker. Memory through metamorphosis in *Manduca sexta*.
2004 **Lepidopterist Society**. College Park, MD. Color learning in Monarch butterflies.

SELECTED PRESS HIGHLIGHTS

New York Times Interview: https://www.nytimes.com/2020/04/03/science/xenobots-robots-frogs-xenopus.html
Scientific American Special: https://www.youtube.com/watch?v=8WyWFAS96ac
Bloomberg Live Interview: https://www.youtube.com/watch?v=akchZ4eG9z8
BBC: http://news.bbc.co.uk/2/hi/science/nature/4181197.stm
CNN: https://www.youtube.com/watch?v=Q_pFkP1PL8w&feature=emb_logo
Engadget: https://www.engadget.com/2020-01-15-uvm-tufts-living-robots-xenobots.html
Forbes: https://www.forbes.com/sites/simonchandler/2020/01/14/worlds-first-living-robot-invites-new-opportunities-and-risks/#325003d43caf
Gizmodo: https://gizmodo.com/made-entirely-from-cells-these-adorable-xenobots-are-1840996434
Popular Science: https://www.popsci.com/technology/xenobots/
The Guardian: https://www.theguardian.com/science/2020/jan/13/scientists-use-stem-cells-from-frogs-to-build-first-living-robots
The Scientist: https://www.the-scientist.com/news-opinion/algorithm-designs-robots-using-frog-cells-66961
Smithsonian: https://www.smithsonianmag.com/innovation/scientists-assemble-frog-stem-cells-first-living-machines-180973947/
Wired: https://www.wired.com/story/xenobot/

AFFILIATIONS, MEMBERSHIPS, AND SERVICE

The Wyss Institute at Harvard University Visiting Scholar
Society for Developmental Biology
Materials Research Society
American Association of Colleges and Universities
Boston Scholars Program Member