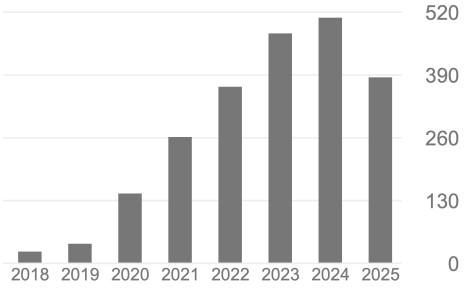
Sam Kriegman **Curriculum Vitae**

Northwestern University, Tech A293
2145 Sheridan Road, Room B224, Evanston, IL 60208
samkriegman.com
www.xenobot.group
sam.kriegman@northwestern.edu

Key Academic Metrics

Citations:	2238
H-index:	18
Publications:	29
Invited Talks:	31
PhD Students:	7
Years since PhD:	5
Last updated:	*Aug 29, 2025*



Google Scholar

Research Statement

My research group explores the emergence of adaptive complexity in robots. Robots that not only compute and learn, but also assemble, repair, and redesign themselves. In pursuit of this, my research brings ideas, algorithms, and materials from biology to robotics and back. Our bioinspired approach is unique in that the entire agent—not just its brain (controller) but also its body (morphology)—is optimized from the ground up, tracing failures in behavior back (through simulation gradients) to errors or inefficiencies in particular parts of the body and brain. The resulting robots often embody adaptive structures and processes characteristic of organisms or their populations. But some of our robots are themselves organisms in a very real sense: they are composed entirely of biological cells.

Appointments

2022– **Assistant Professor**
Department of Computer Science (50%)
Department of Mechanical Engineering (25%)
Department of Chemical & Biological Engineering (25%)
McCormick School of Engineering, Northwestern University

2024– Consultant, Sanooke Toys (spinoff from lab)
2022– Director, Xenobot Lab
2022– Core Faculty, Center for Robotics and Biosystems, Northwestern University
2022– Core Faculty, Center for Synthetic Biology, Northwestern University

2021–2022 **Postdoctoral Fellow**, joint w/ Dept. of Biology, Tufts University; Wyss Institute, Harvard University. Advisor: Michael Levin.

2020–2021 **Postdoctoral Associate**, Dept. of Computer Science, University of Vermont. Advisor: Josh Bongard.

2011–2014 Actuarial Analyst, Chubb Insurance

Education

2016–2020 **Ph.D.**, Computer Science, University of Vermont, USA. Advisor: Josh Bongard.
Dissertation: *Design for an Increasingly Protean Machine*.

2014–2016 **M.S.**, Statistics, University of Vermont, USA
2006–2010 **B.S.**, Applied Mathematics, Ohio University, USA

Funding

2025– **NSF CAREER** award, $576,083.
Differentiable Evolution: Efficient Automatic Design of Embodied Intelligence.

2024– **NSF FRR** award, $814,605. Kriegman portion: $413,909.
D Blackiston and S Kriegman
Modular biological robots with variable morphology.

2024– **Schmidt Sciences AI2050** Collaboration Fund, $120,000.

2023– **Schmidt Futures AI2050 Early Career Fellowship**, $300,000

2023– **Templeton World Charity Foundation** award, $1,749,983. Kriegman portion: $286,600.
PI: J Foster; co-PIs: C Bergstrom, D Krakauer, S Kriegman, M Mitchell, R Rao.
Building Diverse Intelligences through Compositionality and Mechanism Design

2024–2025 **Berggruen Institute Fellowship**, $56,000

2023–2024 **CESR** Seed Grant, $125,000. Kriegman portion: $65,000.
S Kriegman and R Truby
Sustainable Design and Fabrication of Intelligent Robots

Honors and Awards

2024 Kavli Fellow, National Academy of Sciences

2023 Distinguished Early-Career Investigator Award, International Society for Artificial Life

2022 Outstanding Paper of 2021 Award, International Society for Artificial Life

2021 The Cozzarelli Prize, National Academy of Sciences
Outstanding Doctoral Dissertation Award, University of Vermont
Outstanding Paper of 2020 Award, International Society for Artificial Life
Altmetric Top 100, Altmetric

2020 Beazley Designs of the Year, The Design Museum
Top 10 Most Influential BioTech Projects, Project Management Institute
Computer Science Graduate Award, University of Vermont

Articles

12. C Yu, D Matthews, J Wang, J Gu, D Blackiston, M Rubenstein, S Kriegman (*in review*).
Reconfigurable legged metamachines that run on autonomous modular legs.
ArXiv Preprint, arXiv:2505.00784

11. D Matthews, A Spielberg, D Rus, S Kriegman, J Bongard (2023).
Efficient automatic design of robots.
Proceedings of the National Academy of Sciences, 120(41): e2305180120.

10. D Blackiston, S Kriegman, J Bongard, M Levin (2023).

Biological Robots: Perspectives on an Emerging Interdisciplinary Field.
Soft Robotics, 10.1089/soro.2022.0142.

9. D Kudithipudi, M Aguilar-Simon, J Babb, M Bazhenov, D Blackiston, J Bongard, AP Brna, S Chakravarthi Raja, N Cheney, J Clune, A Daram, S Fusi, P Helfer, L Kay, N Ketz, Z Kira, S Kolouri, JL Krichmar, S Kriegman, M Levin, S Madireddy, S Manicka, A Marjaninejad, B McNaughton, R Miikkulainen, Z Navratilova, T Pandit, A Parker, PK Pilly, S Risi, TJ Sejnowski, A Soltoggio, N Soures, AS Tolias, D Urbina-Melendez, FJ Valero-Cueva, GM van de Ven, JT Vogelstein, F Wang, R Weiss, A Yanguas-Gil, X Zou, H Siegelmann (2022).
Biological underpinnings of lifelong learning machines.
Nature Machine Intelligence, 4(3): 196-210.

8. S Kriegman, D Blackiston, M Levin, J Bongard (2021).
Kinematic self-replication in reconfigurable organisms.
Proceedings of the National Academy of Sciences, 118(49): e2112672118.

7. D Blackiston, E Lederer, S Kriegman, S Garnier, J Bongard, M Levin (2021).
A cellular platform for the development of synthetic living machines.
Science Robotics, 6(52): eabf1571.

6. D Shah, J Powers, L Tilton, S Kriegman, J Bongard, R Kramer-Bottiglio (2021).
A soft robot that adapts to environments through shape change.
Nature Machine Intelligence, 3(10): 51-59.

5. D Shah, B Yang, S Kriegman, M Levin, J Bongard, R Kramer-Bottiglio (2020).
Shape Changing Robots: Bioinspiration, Simulation, and Physical Realization.
Advanced Materials, 33(19): 2002882.

4. S Kriegman, D Blackiston, M Levin, J Bongard (2020).
A scalable pipeline for designing reconfigurable organisms.
Proceedings of the National Academy of Sciences, 117(4): 1853-1859.
(*A perspective article on this work by P. Ball can be found here.*)

3. S Kriegman (2019).
Why virtual creatures matter.
Nature Machine Intelligence, 1(10): 492.

2. S Kriegman, N Cheney, J Bongard (2018).
How morphological development can guide evolution.
Scientific Reports, 8(1): 13934.

1. F Corucci, N Cheney, S Kriegman, J Bongard, C Laschi (2017).
Evolutionary developmental soft robotics as a framework to study intelligence and adaptive behavior.
Frontiers in Robotics and AI, 4: 34.

PEER-REVIEWED CONFERENCE PUBLICATIONS

17. S Beaulieu, S Kriegman (*in review*).
Glamour muscles: why having a body is not what it means to be embodied.
ArXiv Preprint, arXiv:2307.08598

16. L Strgar, S Kriegman (*in review*).
Accelerated co-design of robots through morphological pretraining.
ArXiv Preprint, arXiv:2502.10862

15. M Li, L Kong, S Kriegman (2025).
Generating Freeform Endoskeletal Robots.
Intl. Conference on Learning Representations (ICLR).
(Spotlight; top 1.4% of 11.6K submissions; top rated paper in subject area.)

14. L Strgar, D Matthews, T Hummer, S Kriegman (2024).
Evolution and learning in differentiable robots.
Robotics: Science and Systems (RSS), 10.15607/RSS.2024.XX.100.

13. T Hummer, S Kriegman (2024).
A non-cubic space-filling modular robot.
Intl. Conference on Robotics and Automation (ICRA), 2624-2631, 10.1109/ICRA57147.2024.10611176.

12. M Li, D Matthews, S Kriegman (2024).
Reinforcement learning for freeform robot design.
Intl. Conference on Robotics and Automation (ICRA), 8799-8806, 10.1109/ICRA57147.2024.10610048.

11. S Kriegman, A-M Nasab, D Blackiston, H Steele, M Levin, R Kramer-Bottiglio, J Bongard (2021).
Scale invariant robot behavior with fractals.
Robotics: Science and Systems (RSS), 10.15607/RSS.2021.XVII.059

10. J Powers, R Grindle, S Kriegman, L Frati, N Cheney, J Bongard (2020).
Morphology dictates learnability in neural controllers.
Artificial Life Conference (ALife), 52-59.

9. S Kriegman, A-M Nasab, D Shah, H Steele, G Branin, M Levin, J Bongard, R Kramer-Bottiglio (2020).
Scalable sim-to-real transfer of soft robot designs.
Intl. Conference on Soft Robotics (RoboSoft), 359-366, 10.1109/RoboSoft48309.2020.9116004.

8. D Matthews, S Kriegman, C Cappelle, J Bongard (2019).
Word2vec to behavior: morphology facilitates the grounding of language in machines.
Intl. Conf. on Intelligent Robots and Systems (IROS), 4153-4160, 10.1109/IROS40897.2019.8967639.

7. S Kriegman, S Walker, D Shah, M Levin, R Kramer-Bottiglio, J Bongard (2019).
Automated shapeshifting for function recovery in damaged robots.
Robotics: Science and Systems (RSS), 10.15607/RSS.2019.XV.028
(*A perspective article on this work by H. Hauser can be found here.*)

6. S Beaulieu, S Kriegman, J Bongard (2018).
Combating catastrophic forgetting with developmental compression.
Genetic and Evolutionary Computation Conference (GECCO), 386-393, 10.1145/3205455.3205615.

5. S Kriegman, N Cheney, F Corucci, J Bongard (2018).
Interoceptive robustness through environment-mediated morphological development.
Genetic and Evolutionary Computation Conference (GECCO), 109-116, 10.1145/3205455.3205529.

4. J Powers, S Kriegman, J Bongard (2018).
The effects of morphology and fitness on catastrophic interference.
Artificial Life Conference (ALife), 606-613.

3. S Kriegman, C Cappelle, F Corucci, A Bernatskiy, N Cheney, J Bongard (2017).
Simulating the evolution of soft and rigid-body robots.
Genetic and Evolutionary Computation Conference (GECCO), 1117-1120, 10.1145/3067695.3082051.

2. S Kriegman, N Cheney, F Corucci, J Bongard (2017).
A minimal developmental model can increase evolvability in soft robots.
Genetic and Evolutionary Computation Conference (GECCO), 131-138, 10.1145/3071178.3071296.

1. S Kriegman, M Szubert, J Bongard, C Skalka (2016).
Evolving spatially aggregated features from satellite imagery for regional modeling.
Parallel Problem Solving from Nature (PPSN), 707-716.

PATENTS

2025 "Modular legged machines". Provisional.
2025 "Three-dimensional construction blocks with configuration-invariant attachment". Prov. No. 63/618,628
2024 "Efficient automatic design of physical machines with moving parts". US20240281571A1
2022 "Engineered multicellular ciliated organisms and the kinematic self-replication thereof". US20220220437A1
2021 "Engineered multicellular organisms". US20230235296A1

SERVICE

2023– Program committee member, Genetic and Evolutionary Computation Conference (GECCO).
2022– Program committee member, Conference on Artificial Life (ALIFE).
2022 Co-organizer, CD-SoRo (computational design of soft robots) workshop, IROS conference. Kyoto, Japan.
2019–22 Co-developer, Voxcraft: a low-cost, open-source soft robot kit for ages 12+
2017–22 Co-organizer, Virtual Creatures Competition and Workshop.

MEMBERSHIP

2022– International Society of Artificial Life (ISAL)
2022– Association of Computing Machinery (ACM)
2022– Institute of Electrical and Electronics Engineers (IEEE)

REVIEWER

Science, *Nature*, *Nature Communications*, *Nature Machine Intelligence*, *Artificial Life*,
Soft Robotics, *Transactions on Robotics*, *Robotics and Automation Magazine*, and others...

INTERNAL

2024– Faculty Search Committee for "Embodied AI" hire, Depts of Comp Sci and Mech Eng
2022–24 Graduate Studies Committee, Dept of Mech Eng
2022–24 PhD Admissions Committee, Dept of Comp Sci

TEACHING

Fall Evolutionary Computation (Comp Sci 496).
Winter ALife (Artificial Life; Comp Sci/Mech Eng/Chem Eng 302).
Spring DTC (Design Thinking & Communication; Dsgn 106).

ADVISING

STAFF

2022–2024 David Matthews: Differentiable evolution.

PHD'S

2025– Yibin Wang: tbd (Comp Sci).
2024– David Matthews: Residual physics (Comp Sci). NSF GRFP recipient.
2024– Yuchen Cao: Visual perception (Comp Sci).

2024– Zihan Guo: Simulation-reality transfer (Mech Eng).
2023– Luke Strgar: Universal control (Comp Sci).
2023– Chen Yu: Modularity (Comp Sci).
2023– Muhan Li: Simulation (Comp Sci).

MASTERS

2023–25 Lingji Kong (Comp Sci).
2023–24 Isabel Zhong (Biomedical Eng & Comp Sci).
2022–23 Tyler Hummer (Mech Eng).

UNDERGRADS

2024– Aileen Cleary (Mech Eng)
2024– Emily Chi (Mech Eng)
2023–25 Daniel Shamsoddini (Comp Sci)

INVITED TALKS

May 2025 "Replaying the movie of evolution". Berggruen Institute.
Mar 2025 "From AI to ALife". University of Wisconsin, Madison, WI.

Oct 2024 "From AI to ALife". Schmidt AI in Science Seminar Series, University of Chicago.
Mar 2024 "From Artificial Intelligence to Artificial Life". NAS Kavli Frontiers of Science Symposium, Irvine, CA.
Mar 2024 "From Artificial Intelligence to Artificial Life". NASEM Distinctive Voices Lecture, Irvine, CA.
Feb 2024 "Differentiable robot design". Purdue University.

July, 2023 "From artificial intelligence to artificial life". The American Academy of Arts and Sciences.
Apr, 2023 "AI-generated organisms". Illinois Institute of Technology.
Mar, 2023 *Animal Robot* Screening and Discussion. AAAS Annual Meeting, Washington, DC.

Dec, 2022 *Berggruen Institute x Lucy McRae Salon*. Honor Fraser Gallery, Los Angeles.
Oct, 2022 "Selection, the impersonal engineer". AI-Driven Labs Workshop, Argonne National Laboratory.
Sept, 2022 "AI-generated organisms". New Faculty Invited Lecture, Northwestern ChBE Retreat.
May, 2022 "Everything I wish I'd known about the academic job market.". University of Vermont.
Apr, 2022 "Simulating xenobots and xenohybrid machines.". Workshop on software for soft robotics research.
Apr, 2022 "Sim2real for biological robots". Workshop on soft robot design optimization, IEEE RoboSoft Conf.
Mar, 2022 "From Biology to Bots and Back". Luddy School, Indiana University.
Mar, 2022 "From Biology to Bots and Back". CS Colloquium, Northwestern University.
Feb, 2022 "Computer-designed organisms". *Leonardo Art Science Evening Rendezvouz*, Stanford University.
Feb, 2022 "From Biology to Bots and Back". MIT.
Feb, 2022 "Fractal robots". Evolutionary and Learning Machines Group, Vrije Universiteit Amsterdam.
Feb, 2022 "From Biology to Bots and Back". New York University.
Jan, 2022 "From Biology to Bots and Back". Vanderbilt University.

Sept, 2021 "AutoCAD for XenoBOT". Autodesk.
July, 2021 "Evolutionary robotics in a nutshell". ISAL Summer School.
July, 2021 "Sim2Life: AI-generated biological constructs". Cross Roads.
Mar, 2021 "Protean machines". The Creative AI Lab, IT University of Copenhagen.
Mar, 2021 "Living robots". *The Int'l Workshop on Embodied Intelligence*.
Mar, 2021 "How to evolve your robot". Guest lecture, Introduction to Soft Robotics, Yale University.

Oct, 2020 "Living deepfakes". Guest lecture for the MIT Media Lab's Deepfakes course (MAS.S60).
Apr, 2020 "Computer designed organisms". *Artificial Life Virtual Seminar Series*.
Feb, 2020 "Living robots for biomedicine". Biomedical Engineering Society, University of Vermont.

Misc. Lectures

July, 2021 "Fractal robots in 5 minutes". *Robotics: Science and Systems (RSS).*
May, 2020 "Sim2real for soft robot designs". *IEEE International Conference on Soft Robotics (RoboSoft).*
June, 2019 "Shapeshifting robots". *Robotics: Science and Systems (RSS)* in Freiburg, Germany.

Selected Media Coverage

Sept, 2024 "The Sound Of Science". *The Late Show with Steven Colbert*
Jun, 2024 "From Code to Creature". *The Scientist*

Nov, 2023 "**For first time, researchers use artificial intelligence to build a robot**". ***CBS Evening News***
Oct, 2023 "AI design for a 'walking' robot is a squishy purple glob". *Popular Science*
Oct, 2023 "AI Designs Little Robots in 30 Seconds and They Keep Sprouting Legs". *Scientific American*
Oct, 2023 "AI designs new robot from scratch in seconds". *New Scientist*
Oct, 2023 "'Instant evolution' in 26 seconds". *USTV Taiwan*
Oct, 2023 "AI was told to design a robot that could walk...". *Business Insider*
Oct, 2023 "**Generation AI: If you want something done**". ***Reuters***
Oct, 2023 "AI designs new robot from scratch in seconds". *Reuters*
Oct, 2023 "AI creates a robot from scratch in seconds at Northwestern University". *CBS Morning News Chicago*
Mar, 2023 "Animal Robot" documentary. *Scientific American and the Howard Hughes Medical Institute*
Feb, 2023 "Here come the xenobots". *BBC Science Focus*

Sept, 2022 "Xenobot". *Dictionary.com*
Aug, 2022 "What on earth is a xenobot?". *Aeon magazine*
July, 2022 "Virtual critters evolve bodies that help them learn". *Science News for Students*
Jan, 2022 "**Scientists create 'robots' that are capable of reproduction (with Jericka Duncan)**". ***CBS Evening News***

Dec, 2021 "Here are our favorite cool, funny and bizarre science stories of 2021". *Science News*
Dec, 2021 "Living robots that are capable of self-replicating created in US lab". *BBC Science Focus*
Dec, 2021 "Scientists Create 'Living Machines' With Algorithms, Frog Cells". *Bloomberg Businessweek*
Dec, 2021 "**It's not science fiction. Scientists have really made robots that reproduce**". ***NPR Weekend Edition***
Dec, 2021 "Living robots made in a lab have found a new way to self-replicate, researchers say". *NPR*
Dec, 2021 "Self replicating xenobots". *BBC World Service*
Dec, 2021 "The creation of self-replicating biobots". *BBC Science in Action*
Dec, 2021 "Diving Into The Strange World Of Xenobots". *Science Friday*
Dec, 2021 "'Living robots' made of frog cells found a way to reproduce". *CNBC: The News with Shepard Smith*
Dec, 2021 "Scientists unveil 'Pac-Man' living robots". *ABC News*
Dec, 2021 "Xenobots – US Scientists Create Tiny Living Robots That Can Reproduce". *Voice of America*
Dec, 2021 "100 years of robots: How technology – and our lives – have changed". *Chicago Tribune*
Dec, 2021 "UVM researchers make strides in 'living robot' reproduction". *WCAX (CBS 3)*
Dec, 2021 "Stephen Colbert's Cyborgasm". *The Late Show with Steven Colbert*
Dec, 2021 "World's First Living Robots Can Now Reproduce, Say Scientists". *The Onion*
Dec, 2021 "Scientists Unveiled the World's First Living Robots... Now, They Can Reproduce". *Smithsonian Magazine*
Dec, 2021 "Tiny living Pac-Man robots have learned how to reproduce". *CNN*
Nov, 2021 "These living robots made of frog cells can now reproduce, study says". *Washington Post*
Nov, 2021 "World's first living robots can now reproduce, scientists say". *New York Post*
Nov, 2021 "'Amazing science': researchers find xenobots can give rise to offspring". *The Guardian*
Nov, 2021 "World's first living robots can now reproduce, scientists say". *CNN*
Nov, 2021 "Daily briefing: Multicellular living robots build their own offspring". *Nature*
Nov, 2021 "Scientists made tiny xenobots out of frog cells. Now they say those robots can reproduce.". *USA Today*
Nov, 2021 "Xenobots that self-replicate created by scientists". *The Times*
Nov, 2021 "World's first 'living robots' start to reproduce". *The Telegraph*
Nov, 2021 "AI Just Designed The World's First Living Robot That Can Make Babies". *Forbes*

Nov, 2021 "Researchers behind the world's first living robot have found a way to make it reproduce". *Business Insider*
Nov, 2021 "Xenobots, the World's First Living Robots, Are Now Capable of Reproducing". *People Magazine*
Nov, 2021 "Mesmerizing Video Shows How Tiny 'Living Robot' Xenobot Cells Reproduce". *Newsweek*
Nov, 2021 "Living robots made from frog cells can replicate themselves in a dish". *New Scientist*

Hundreds of additional articles appeared in the global press following our third xenobots paper.

Nov, 2021 "The Machine That Feels". *CBC TV*
Jun, 2021 "Biological Robots May Soon Build You a Better Heart". *Bloomberg Moonshot*
Apr, 2021 "Frog stem cell research changes what we know about how organisms are built". *Washington Post*
Apr, 2021 "Robots made out of frog cells". *Science Friday*
Mar, 2021 "Cells Form Into 'Xenobots' on Their Own". *Quanta Magazine*
Mar, 2021 "Living robots made from frog skin cells can sense their environment". *New Scientist*
Mar, 2021 "Frog skin cells turned themselves into living machines". *Science News*

Dec, 2020 "The big scientific breakthroughs of 2020". *The Week*
Dec, 2020 "The 10 Most Spectacular Scientific Advances of 2020". *La Razón (Spain)*
Dec, 2020 "Part Robot, Part Frog: Xenobots Are the First Robots Made From Living Cells". *Discover Magazine*
Nov, 2020 "The Xenobot Future Is Coming – Start Planning Now". *Wired*
Apr, 2020 "Meet the Xenobots: Virtual Creatures Brought to Life". *New York Times*
Apr, 2020 "What if, Instead of the Internet, We Had Xenobots? ". *New York Times*
Feb, 2020 "Living Robots". *TalkSport Radio*
Feb, 2020 "Giant Moon rocket, living robots and quantum computer – January's best science images". *Nature*
Feb, 2020 "Living robots built from frog cells". *BBC Science Focus*
Feb, 2020 "Tiny machines made from the stem cells of frogs". *The Intelligence (Economist Radio)*
Jan, 2020 "A research team builds robots from living cells". *The Economist*
Jan, 2020 "The religious, moral, and ethical implications of Xenobots". *BBC Radio 4 Sunday*
Jan, 2020 "Scientists use stem cells from frogs to build first living robots". *The Guardian*
Jan, 2020 "Xenobot: how did earth's newest lifeforms get their name? ". *The Guardian*
Jan, 2020 "Meet the xenobot: world's first living, self-healing robots created from frog stem cells". *CNN*
Jan, 2020 "Scientists create first living, self-healing robots (on-air with Fredricka Whitfield)". *CNN*
Jan, 2020 "Meet Xenobot, an Eerie New Kind of Programmable Organism". *Wired*
Jan, 2020 "Scientists Assemble Frog Stem Cells Into First 'Living Machines'". *Smithsonian Magazine*
Jan, 2020 "World's First 'Living Machine' Created Using Frog Cells and Artificial Intelligence". *Scientific American*
Jan, 2020 "Scientists at UVM, Tufts create 'living robots'". *Boston Globe*
Jan, 2020 "How tiny 'biobots' could enter bodies to clean arteries and administer drugs". *The Times*
Jan, 2020 "Living robots created as scientists turn frog cells into 'entirely new life-forms'". *The Telegraph*
Jan, 2020 "'Robots vivientes' hechos a partir de tejido de ranas, llamados Xenobots". *Noticieros Televisa*
Jan, 2020 "Living Robots, Designed By Computer". *Science Friday*
Jan, 2020 "Living robots". *BBC World Service*
Jan, 2020 "Tiny 'xenobots' made from cells could heal our bodies and clean the environment". *Fox News*
Jan, 2020 "World's first 'living robots' are made from the stem cells of frogs". *New York Post*
Jan, 2020 "Xenobots: 1st living robots made from stem cells". *ESPN*
Jan, 2020 "Xenobot". *Wikipedia*

Hundreds of additional articles appeared in the global press following our announcement of Xenobots.