

Shicong (Mimi) Xie, PhD

Postdoctoral Fellow

Department of Biology

Stanford University

xies@stanford.edu

ORCID: 0000-0002-3283-3248

RESEARCH INTEREST

I am interested in understanding fundamental cell biology within multicellular contexts. Specifically, I am interested in size homeostasis across many biological scales. How do cells maintain constant size despite growth and division cycles? How do organs maintain their size despite dramatic tissue turnover? How does cell size impact cell function? In order to answer these questions, I combine long-term single cell imaging in living mammals, quantitative image analysis, and statistical modeling.

EDUCATION

Ph.D. Computational & Systems Biology

Massachusetts Institute of Technology, Cambridge, MA

2010 - 2016

B.A. Double major: Physics, Applied Mathematics (Highest honors)

University of California, Berkeley, Berkeley, CA

2006 - 2010

RESEARCH EXPERIENCE

Postdoctoral Researcher

Stanford University, Stanford, CA

Advisor: *Jan Skotheim, Department of Biology*

2016-present

Cell size control in mammalian epithelial tissues

- ***In vivo* analysis of 4D epithelial dynamics.** I used intravital imaging to track hundreds of single skin stem cells over a week in 3-dimensions *in vivo*. I developed a suite of computational tools that combine classical machine vision with deep-learning methods to densely extract geometric and dynamic information about single stem cells and their native 3D tissue microenvironment. I used these tools to analyze cell growth and cell cycle dynamics in adult mouse stem cells as well as osteoblasts during scale regeneration in zebrafish.
- **Statistical modeling of stem cell cycle heterogeneity.** I integrated cell- and tissue-level features of geometric, topology, cell cycle progression, and neighbor cell fate dynamics, into statistical models that quantify their contribution to tissue dynamics. I found that cell size is the major determinant of highly heterogeneous cell cycle lengths in adult skin stem cells.

- **The G1/S transition is autonomously coupled to a cell size threshold.** I discovered the G1/S cell cycle transition is cell size-dependent in skin stem cells growing *in vivo* skin and in intestinal stem cells growing in organoid culture. Using laser ablations to ablate and disrupt the tissue microenvironment, I found that this cell size threshold is cell-autonomously encoded and does not depend on microenvironment state.
- **Rb1 concentration couples cell size to the G1/S transition *in vivo*.** I found that the concentration of the S phase inhibitor Rb1 couples cell size to the G1/S transition in mouse skin stem cells *in vivo*.

Friedrich Miescher Institute, Basel, Switzerland

Jan - Mar, 2020

Collaborator: Prisca Liberali

- **Lightsheet imaging of intestinal organoids.** I visited the lab of Dr. Liberali to use lightsheet imaging to study single cell growth in intestinal organoids. I developed computational tools to analyze single cell growth from light sheet datasets.

Graduate Research

Massachusetts Institute of Technology, Cambridge, MA

2010 - 2016

Advisor: Adam C. Martin, Department of Biology

Tissue-scale coordination of contractile forces during morphogenesis

- **Investigation of intercellular coordination during collective apical constriction.** I discovered how actomyosin contractions are coordinated to drive tissue folding during *Drosophila* ventral furrow invagination.
- **Computational image analysis of pulsatile actomyosin contractions.** Combining techniques from machine learning, image analysis, and spatial statistics, I developed a computational framework to analyze pulsatile contraction events that drive collective cell constriction.
- **GPCR-signaling buffers actomyosin contractions against cell size heterogeneity.** I uncovered the mechanism by which $G_{\alpha 12/13}$ -signaling coordinates apical constrictions the *Drosophila* ventral furrow by buffering actomyosin contractions against cell size-dependent defects.

Undergraduate Research

University of California, Berkeley, Berkeley, CA

2007 - 2010

Advisor: John Kuriyan, Departments of Molecular & Cell Biology, Chemistry

- Super-resolution imaging of EGFR receptor clustering

HHMI Janelia Research Campus, Ashburn, VA

2009

Advisor: Harald Hess

- Automation of alignment and focus of the interferometric photoactivatable localization microscope (iPALM)

NASA Ames Research Center, The SETI Institute, Mountain View, CA 2007
Advisor: Friedemann Freund

- Characterization of the electrochemistry of water-rock interfaces for igneous rock under mechanical stress

GRANTS & FELLOWSHIPS

K99 Pathway to Independence Award 2020 - 2023
NIH NIGMS K99GM138712

F32 Individual Postdoctoral Fellowship 2018 - 2020
NIH NIGMS F32GM129878

- Title: Determining how the G1/S cell cycle transition regulates the homeostasis of adult intestinal stem cells

Company of Biologists, Journal of Cell Science Jan - Mar, 2020
 Travelling Fellow

AWARDS

- Santa Cruz Developmental Biology Conference, Young Investigator Award 2024
- International Society for Stem Cell Research Conference, Merit Award 2024
- CytoData Meeting Single Cell Image Analysis Hackathon, Grand Prize winning team 2022
- NIH Stadtman Fellow finalist 2022
- MIT Department of Biology, Retreat Poster Prize 2011
- Regents' and Chancellors' Scholarship, UC Berkeley 2006 - 2010
- Dean's List, UC Berkeley 2006 - 2008
- Phoebe Hearst Scholar 2006 - 2008
- Genzyme Science Scholarship 2006
- Robert Byrd Honors Scholarship 2006
- National Merit Scholar 2006
- Scholastic National Art & Writing Awards, Silver Medal in Creative Writing Portfolio 2006

INVITED OR SELECTED TALKS

- **Satan Cruz Developmental Biology Meeting, Young Investigator Award.** Keeping to the same size: A cell size homeostasis mechanism autonomously determines the G1/S transition in mammalian stem cells *in vivo*. Santa Cruz, CA. August, 2024
- **Gordon Research Seminars, Epithelial Stem Cells and their Niches.** A cell size homeostasis mechanism autonomously determines the G1/S transition in mammalian stem cells *in vivo*. Castelldefels, Spain. August, 2024
- **International Society for Stem Cell Research Conference (ISSCR).** A cell size homeostasis mechanism autonomously determines the G1/S transition in mammalian stem cells *in vivo*. Hamburg, Germany. July, 2024
- **CZ Biohub, Physics of Life Symposium.** Cell size homeostasis autonomously determines G1/S timing in the mouse skin. San Francisco. Oct, 2023
- **Gordon Research Conference, Cell growth and Proliferation.** Cell size homeostasis autonomously determines G1/S timing in the mouse skin. Mount Snow, VT. Jul, 2023
- **FMI Young Investigator Seminar Series.** Stem cell size homeostasis in mammalian epithelia. Basel, Switzerland. Sep, 2022
- **Americal Society for Cell Biology & European Molecular Biology Organization Meeting (ASCB & EMBO).** Cell size-dependent G1/S transition controls stem cell size in epidermal and intestinal stem cells. Online. Dec, 2021
- **College de France, Center for Interdisciplinary Research in Biology Seminars.** Cell size-dependent G1/S transition controls stem cell size in mammalian epithelia. Paris, France. Oct, 2021
- **4th International Conference on Stem Cells.** Cell size-dependent G1/S transition controls stem cell size in epidermal and intestinal stem cells. Kos, Greece. Oct, 2021
- **Stanford Biology Postdoc Symposium.** Cell size-dependent G1/S transition controls stem cell size in mammalian epithelia. Stanford, CA. May, 2021
- **Cell Size and Growth seminar series.** G1 sizer coordinates cell size and cell cycle in mammalian stem cells. Online. Apr, 2020
- **Gordon Research Conference, Stochastic Physics in Biology.** Interactions Between Contractile Events During Tissue Folding. Ventura, CA. Oct, 2015
- **Drosophila Research Conference.** Coordinating pulsed and ratcheted contractions during Drosophila ventral furrow formation. San Diego, CA. Mar, 2014

MEETING ORGANIZER

- **Cell Size and Growth Seminar Series.** Biweekly seminar series on cell size and growth. Online. Jan-July 2025
- **ISSCR Spotlight.** A 90-min symposium with five invited speakers: “Stem Cell Size and Shape: Emerging Links to Stem Cell Function.” Online. April, 2024

- **Think & Drink Seminar Series.** A weekly community and trainee seminar series in the Department of Biology at Stanford University. Stanford, CA. 2018-2022
- **Mechanical Forces in Development.** A monthly seminar series in the Boston area on mechanobiology, emphasizing tissue models. Cambridge, CA. 2012-2013

PUBLICATIONS

1. **Xie S**, Zhang S, de Medeiros G, Liberali P, Skotheim JM (2024). The G1/S transition in mammalian stem cells *in vivo* is autonomously regulated by cell size. *bioRxiv*. (In revision at *Nature*) [link]
2. **Xie S**, Swaffer M, Skotheim JM (2022). Eukaryotic Cell Size Control and Its Relation to Biosynthesis and Senescence *Annual Review of Cell and Developmental Biology*, 38(1), pp.291-319. [link]
3. **Xie S** and Skotheim JM (2021). Cell-size control: Chromatin-based titration primes inhibitor dilution. *Current Biology*, 31(19). 1127-1129. [link]
4. **Xie S** and Skotheim JM (2020). A G1 Sizer Coordinates Growth and Division in the Mouse Epidermis. *Current Biology*, 30(5). 916-924. [link]
5. Berenson DF, Zatulovskiy E, **Xie S**, Skotheim JM (2019). Constitutive expression of a fluorescent protein reports the size of live human cells. *Molecular Biology of the Cell*, 30(24), 2985-2995. [link]
6. Shariati SA, Dominguez A, **Xie S**, Wernig M, Qi SL, Skotheim JM (2019). Reversible disruption of specific transcription factor-DNA interactions using CRISPR/Cas9. *Molecular Cell*, 74(3), 622-633. [link]
7. Topacio BR, Zatulovskiy E, Cristea S, **Xie S**, Tambo CS, Rubin SM, Sage J, Kõivomägi M, Skotheim JM (2019). Cyclin D-Cdk4, 6 Drives Cell-Cycle Progression via the Retinoblastoma Protein's C-Terminal Helix. *Molecular Cell*, 74(4), 758-770. [link]
8. **Xie S**, Mason FM, Martin AC (2016). Loss of G $_{\alpha 12/13}$ exacerbates apical area-dependence of actomyosin contractility. *Molecular Biology of the Cell*, 27(22), 3526-3536. [link]
9. Mason FM, **Xie S**, Vasquez CG, Tworoger M, Martin AC (2016). RhoA GTPase inhibition organizes contraction during epithelial morphogenesis. *Journal of Cell Biology*, 214(5), 603-617. [link]
10. **Xie S** and Martin AC (2015). Intracellular signalling and intercellular coupling coordinate heterogeneous contractile events to facilitate tissue folding. *Nature Communications*, 6(1), 1-13. [link]
11. Tikhonova EB, Ethayathulla AS, Su Y, Hariharan P, **Xie S**, Guan L (2015). A transcription blocker isolated from a designed repeat protein combinatorial library by in vivo functional screen. *Scientific Reports*, 5(1), 1-11. [link]

MENTORING AND TEACHING

Mentor: Stanford Community College Outreach Program (1 student) Fall 2024

- I am mentoring a student from a local community college for his first research experience in biology. I am helping him to analyze whether there is cell size-bias in differentiation rates in the mammalian skin, while teaching him how to analyze images and data using image analysis and data science libraries in Python.

Mentor: Stanford Biology Summer Undergraduate Research Program (1 student)
Summer 2023

- I mentored a summer student using intravital imaging to analyze cell growth rates following laser ablation. I helped her organized an independent project on using topical tamoxifen treatment to generate mosaic mutant clones in the mouse skin.

Mentor: Stanford summer undergraduate student (1 student) Summer 2022

- I mentored a summer student in using Python/NumPy to computationally analyze cell growth rates during keratinocyte differentiation.

Mentor: Stanford ADVANCE Summer Institute (1 student) Summer 2021

- I organized and discussed papers on using image analysis and deep-learning to solve common problems in biology with my student. I mentored my student on giving a formal scientific presentation on the topic to her peers. ADVANCE is a summer program that prepares incoming graduate students from nontraditional undergraduate backgrounds for non-research scientific skills.

Mentor: Stanford RISE Internship Program. (2 students) Summer 2019

- I co-mentored two high school interns through the Stanford RISE program designed for low-income high school students. I taught them foundational concepts in computer programming through a basic image analysis project.

Mentor: MIT Undergraduate Research Apprentice Program. (1 student) Fall 2012.

- I mentored an undergraduate mathematics student in using statistical modeling and Monte Carlo simulations to determine transition points in dynamic biological data.

Workshop: MIT Quantitative Biology Workshop. (40 students) Winter 2012,4

- I developed and taught a minicourse on analyzing biological motion using image analysis in MATLAB and Python/NumPy. This was a part of an on-site workshop series designed to introduce quantitative methods in

biology to undergraduates from under-represented backgrounds and undergraduate institutions that did not have strong research presence.

Course: MIT Biological Engineering 20.430, Physical biology. (14 students) Fall 2011

- I helped develop and teach a graduate course in physical biology (20.430), covering topics like statistical mechanics, polymer models, biological motion, and tissue mechanics. Specifically, I helped develop the use of Monte Carlo simulations as the unifying computational technique covered in the course.

POSTERS

- **Xie S**, Zhang S, de Medeiros GQG, Liberali P, Skotheim JM. Cell size homeostasis autonomously determines the G1/S transition in the mammalian stem cells *in vivo*. Gordon Research Conference on Epithelial Stem Cells and their Niches. 2024. Castelldefels, Spain.
- **Xie S**, Zhang S, de Medeiros GQG, Liberali P, Skotheim JM. Cell size homeostasis autonomously determines the G1/S transition in mammalian epidermis. American Society for Cell Biology. 2023. Washington DC.
- **Xie S**, Zhang S, de Medeiros GQG, Liberali P, Skotheim JM. Cell size homeostasis autonomously the G1/S transition in mammalian epidermis. International Society for Stem Cell Research Meeting. 2022. Boston, MA.
- **Xie S**, de Medeiros GQG, Liberali P, Skotheim JM. Stem cell size homeostasis in mammalian epithelia. CytoData Meeting. 2022. Seattle, WA.
- **Xie S**, de Medeiros GQG, Liberali P, Skotheim JM. Stem cell size homeostasis in mammalian epithelia. Santa Cruz Developmental Biology Meeting. 2022. Santa Cruz, CA.
- **Xie S**, de Medeiros GQG, Liberali P, Skotheim JM. Cell size-dependent G1/S transition controls stem cell size in mammalian epithelia. The Salk Institute Cell Cycle Meeting. 2021. Online.
- **Xie S** and Skotheim JM. G1 sizer couples cell cycle and cell growth in epidermal stem cells *in vivo*. Gordon Research Conference on Cell Growth and Proliferation. 2019. Mt. Snow, VT.
- **Xie S**, Mason FM, Martin AC. Loss of $G_{\alpha 12/13}$ exacerbates apical area-dependence of actomyosin contractility. American Society for Cell Biology Meeting. 2016. San Francisco, CA.
- **Xie S** and Martin AC. Twist signaling and intercellular coupling coordinate pulsed and ratcheted apical contractions during tissue folding. American Society for Cell Biology Meeting. 2014. Philadelphia, PA.
- **Xie S** and Martin AC. Coordinating the pulsed and ratcheted contractions in the *Drosophila* ventral furrow. *Drosophila* Research Conference. 2014 San Diego, CA.
- **Xie S** and Martin AC. Interactions Between Contractile Events During Tissue Folding. Gordon Research Conference on Contractile and Motile Systems. 2013. New London, NH.

MEMBERSHIPS

- The American Society for Cell Biology 2019 - present
- The Biophysical Society 2020 - present
- International Society for Stem Cell Research 2020 - present

OTHER PUBLICATIONS

Cover art

- *Molecular Cell*, Volume 81, Number 23.

Poetry

- *Berkeley Poetry Review*, Issue No. 40: “bread also”
- *Berkeley Poetry Review*, Issue No. 41: “this expectant rose”
- *Sinθ magazine*, Issue No. 10: “Moon”