NIKITA SIVAKUMAR

I am a PhD candidate in Biomedical Engineering. I leverage data-driven methods (dimensionality reduction, clustering, machine learning, and deep learning) alongside mechanistic models (agent-based, ODE, network, PK/PD) to identify molecular and cellular drivers of disease. I have worked with sparse and high-dimensional biological data, including single-cell transcriptomics, multi-channel imaging, medical imaging, and clinical measurements. I am seeking industry internships where I can apply my expertise in computational biology to advance precision medicine.

Education

Johns Hopkins University
Ph.D. Biomedical Engineering
GPA: 4.0/4.0; **In progress.**

University of Virginia
B.S. Biomedical Engineering,
Minors in Computer Science & Engineering Business
GPA. 3.86/4.0; **May 2022.**

Thomas Jefferson High School for Science & Technology
GPA. 4.250; **June, 2018**.

Skills

Computational Systems Bioengineering

Mechanistic. Agent-based, Cellular Potts, ODE, signaling network, PK/PD, uncertainty quantification, parameter optimization, sensitivity analysis.

Data science. Dimensionality reduction, unsupervised clustering, image analysis, machine learning, deep learning, foundational models.

Omics & Big Data

FastQC, STAR alignment, differential expression, GWAS, single-cell and spatial transcriptomic analysis (cell type identification, cell-cell interaction analysis, community detection), metabolite set enrichment analysis.

Programming

Python (*numpy, pandas, matplotlib, seaborn, scikit-learn, scipy, pytorch, scanpy*), R (*tidyverse*, *ggplot*, *Shiny, Seurat*),
C++, Java, MatLab, Bash, HPC/SLURM, NetLogo

Computational Biology Experience

PhD Candidate
Johns Hopkins University
August, 2022-Present
PIs: Dr. Feilim Mac Gabhann & Dr. Jude Phillip
Focus: Systems Immunology

- **Thesis:** Integrating **machine learning and mechanistic modeling to understand how single-cell lymphocyte motility and spatial organization drive the antibody response** to infection or vaccination.
- Built an unsupervised machine learning pipeline to quantify emergent single-cell motility behaviors from time-lapse, imaging data.
- Developed & validated agent-based simulation to simulate observed single-cell motility behaviors to predict their impact on cell-cell interaction.
- Developing mixed distribution parameter estimation methods,
- Developing statistical approaches to quantify cell spatial organization from sparse imaging data and applying simulations to understand how spatial context influences immune behavior.
- Contributing to foundational models that predict cell behavior and impact.
- **Outcomes:** 3 contributed talks, 4 poster presentations, 2 manuscripts

Clinical Data Scientist
Johns Hopkins University
May, 2023-May, 2024
PIs: Dr. Jude Phillip, Dr. Peter Abadir, Dr. Lolita Nidadvolu
Focus: Computational Medicine & Aging

- Applied unsupervised machine learning to identify novel tissue damage signatures from cell-free, methylated DNA in aging patients.
- Identified novel metabolic pathways enriched with each tissue damage signature to gain mechanistic insights.
- Found **predictive associations between cell-free DNA (liquid biopsies) and co-morbidities, including cardiovascular disease and frailty**.
- **Outcomes:** 1 conference abstract, 1 manuscript

Precision Care Medicine Lead
Johns Hopkins University
August, 2022-May, 2023
PIs: Dr. Joe Greenstein, Dr. Casey Taylor, Dr. Catherine Simpson
Focus: Computational Medicine

- Led a multidisciplinary engineering team in applying unsupervised machine learning to **identify novel pressure-volume coupling phenotypes within pulmonary hypertension patients**. Applied supervised machine learning approaches to predict these phenotypes using standard multimodal measurements of the heart (hemodynamics, MRI).
- **Outcomes:** 2 contributed talks, 1 poster presentation, 1 manuscript

Transcriptomic Tool Developer
Johns Hopkins University
August, 2022 - October, 2022
PIs: Dr. Jean Fan
Focus: Spatial transcriptomics

- Developed a novel algorithm to **identify distinct multi-cellular spatial patterns from spatially-resolved, single-cell transcriptomic data**.
- Integrated superpixelation, connected components, and graph-based clustering algorithms to identify distinct multi-cellular, spatial patterns from *CODEX* and *MERIFISH* datasets.

Systems Biology Researcher
University of Virginia
January, 2019 - August, 2022
PIs: Dr. Shayn Peirce-Cottler & Dr. Matthew Lazzara
Focus: Systems biology

- Developed and validated agent-based model of synthetic gene circuits that induce differential adhesion between cell types to drive multicell spheroid patterning. Performed sensitivity analysis on this model to **identify time- and space- dependent cell behaviors that regulate multicell patterning in development and disease processes**.
- Created and implemented a novel sensitivity analysis pipeline that utilizes unsupervised machine learning to identify how combinations of cell-to-cell signaling parameters drive the formation of distinct multicell patterns.
- Developed and implemented an evolutionary algorithm for parameter estimation. Created architectures to deploy model in parallel and on HPC.
- Created image analysis and data visualization pipelines to analyze experimental data and directly compare simulation results.
- **Outcomes:** 3 contributed talks, 3 poster presentations, 1 manuscript, 2 review articles

Undergraduate researcher
University of Virginia
August, 2020 - December, 2020
PI: Mete Civelek, Ph.D. (BME)
Focus: Single-cell transcriptomics

- Analyzed single-cell RNAseq data from primary, circulating, and secondary pancreatic cancer tumor samples to explore intra-tumoral heterogeneity.
- Quantified cell-type specific variation in expression of epithelial-mesenchymal transition markers.
- Performed single-cell RNAseq quality control, alignment, cell-type identification, and differential gene expression analyses.

Undergraduate researcher
University of Virginia
October, 2020 - January, 2021
PIs: Dr. Gianluca Guadagni
Focus: Epidemiological simulation

- Developed an agent-based simulation framework to simulate the spread of Covid-19 across the UVa campus.
- Implemented student specific movement patterns on a spatially-accurate map along with interventions including masking, social distancing, hybrid courses, and quarantining.
- Quantitatively identified public measures that could contain the spread of the disease.
- **Outcomes:** 1 contributed talk

Teaching Experience

Graduate Student Professor- Introduction to Data-Driven Computational Modeling [1], Mechanistic and Data-Driven Insights into Disease[2], Data Science-Driven Simulations[3]
Johns Hopkins University
September, 2023 - January, 2025

- [1]Designed and taught two-credit fall semester course that explored applying data-driven methods to develop and parameterize agent-based simulations of complex, real-world systems. Mentored students on semester-long team projects that spanned topics including cancer metastasis, supply chain management, and information dissemination.
- [2]Designed and taught two-credit intersession course that explored deterministic, stochastic, and data-driven modeling to understanding biological diseases from a multiscale perspective.
- [3]Designed and taught two sections of 1-credit undergraduate fall course that introduced students to building mathematical simulations to answer multi-disciplinary research questions.

Teaching Assistant - Precision Care Medicine
Johns Hopkins University
September, 2023 - May, 2024

- Mentored student teams on ML projects in collaboration with clinicians at the Johns Hopkins School of Medicine.
- Notable projects included deep learning models to predict eye torsion, convolutional neural networks to improve pulse oximetry measurements in darker skin tones, and unsupervised approaches to improve skin allergy subtype identifications.

Undergraduate Student Professor-
Introduction to Agent-Based Modeling in Biology[1], Introduction to Data Science Driven Modeling[2]
University of Virginia
[1]August, 2019 - May, 2020
[2]August, 2021 - December, 2021

- Designed curriculum for one-credit course on agent-based modeling to undergraduate- and graduate- level students. Taught course for two semesters to a total of 20 students.[1]
- Refined this curriculum to offer a new course on integrating stochastic modeling and data-driven techniques to explore real-world systems. Taught course for one semester to 14 enrolled students.[2]
- Wrote and delivered 10 weekly lectures, created student assessments, and mentored students on team-based, semester-long modeling projects of their choice. Modeling projects have included embryonic stem cell differentiation, Covid-19 transmission, and fake news spread.

Awards

Achievement Rewards for College Scientists Fellowship (October, 2025)
Named an ARCS scholar by the Metropolitan Washington DC chapter for her thesis work in identifying tunable immune cell behaviors that shape an effective antibody response. Awarded $15,000 by the Global Autoimmune Institute.

INBT Symposium Best Poster Award (May, 2025)
Won $500 best graduate poster award at the Annual Institute for NanoBiotechnology Symposium for her poster on multi-scale modeling of immune interactions.

BME Distinguished Teaching Award (October, 2024)
Awarded the JHU departmental distinguished teaching award for her contribution to designing and teaching three successful undergraduate courses and serving as a teaching assistant for Precision Care Medicine.

National Science Foundation Graduate Research Fellowship (August, 2023 - August, 2026)
Awarded the NSF GRFP award as an undergraduate in April, 2022 which provides a $34,500 stipend for three years of PhD studies at any institution.

Johns Hopkins University Biomedical Engineering Rotational Fellowship (August, 2022 - August, 2023)
Received fellowship to conduct first-year PhD studies in several labs at the John Hopkins BME program.

UVa School of Engineering and Applied Sciences Outstanding Student Award (April, 2022)
Recognized as an outstanding student in the school of engineering at UVa and presented with an engraved Revere Bowl.

Global Infectious Disease Institute Undergraduate Excellence In Research Award (January, 2021)
Team of two recognized with $500 award for developing a computational model that predicted Covid-19 spread at UVa.

Arnold & Mabel Beckman Scholarship (March, 2020 - August, 2021)
This scholarship is one of the top national research awards for undergraduates. Received $21,000 to continue predictive modeling of multicellular pattern formation over two summers and one academic year.

NanoStar Summer Undergraduate Research Program Fellowship (June, 2019 - August, 2019)
Awarded $3,000 to conduct summer undergraduate research aimed on applying agent-based modeling to identify cell-cell behaviors that impact pattern formation in development and disease.

Leadership & Outreach

Co-president of Women of Whiting
Johns Hopkins University
June, 2024- Present
Co-presidency started in 2025

- Leads the primary women advocacy student group for Johns Hopkins engineering graduate students.
- Spearheading the implementation of a monthly lunch series with women professors at Hopkins to create a space for graduate students to learn about the unique nuances of navigating academia as a woman in STEM.
- Organizes an annual Women of Whiting conferences (100+ registrants) that brings together women in industry and academia from the local DMV area for a series of professional development activities.

Lab Manager for the Phillip Lab
Johns Hopkins University
June, 2023- June, 2024

- Coordinated logistics for lab maintenance, purchases, and social events for the Phillip Lab.
- Advocated for the Phillip Lab at monthly meetings with the Institute for NanoBiotechnology administration.

Data Team Lead, Dysphagaid
Engineering Going Global (EGG)
September, 2018 - May, 2022

- Led the data-driven modeling group at Dysphagaid, a student team of biomedical engineers that focused on creating a drinking aid for patients with the swallowing disorder, dysphagia.
- Guided team in applying web scraping and natural language processing to assess patient sentiment towards current dysphagia products and used this data to define new design requirements.

Teaching Design Engineer
Clark Elementary School
August, 2018 - December, 2018

- Collaborated with team of engineers to create a hands-on fraction math game to aid in student learning.
- Worked with local third grade class to understand difficulties young students face with grasping math concepts in the classroom.

Girl Scout Senior
Girl Scouts for America
September, 2008 - August, 2018

- Earned the **Girl Scout Gold Award**, the highest honor a girl scout can receive, for developing and implementing a program for learning effective study strategies for local high schoolers.
- Logged 1000+ hours of local, national and global service through consistent activities such as volunteering at local soup kitchens, tutoring students in the local community, honoring veterans, and volunteering at a deaf and dumb school in Chennai, India.

Peer-reviewed publications

N. Sivakumar, C. Min , L. Choe, W. Beguelin, F. Mac Gabhann, J.M. Phillip. "A computational platform to predict how lymphocyte motility drives germinal center B-T interactions." *Biorxiv*. 2025. https://doi.org/10.1101/2025.08.05.668700

N. Sivakumar, C. Zhang, C. Chang-Chien, …, C.O. Taylor, J. Greenstein, S. Hsu, P.M. Hassoun, C.E. Simpson. "A machine learning approach to predict emergent right ventricular pressure-volume phenotypes in pulmonary hypertension." *Pulmonary Circulation*. 2025.https://doi.org/10.1002/pul2.70057

L.S. Nidadavolu*, D. Sosnowski*, **N. Sivakumar***, D.A. Bennett, J.M. Phillip, B. Maher, J.D. Walston, E.S. Oh, P.M. Abadir. "Cardiovascular-Derived Cell-Free DNA: Associations With Frailty and Aging-Related Comorbidities." *Journal of Gerontology: Biological Sciences*. 2025. https://doi.org/10.1093/gerona/glaf081

D. Maity*, **N. Sivakumar***, P. Kamat, …, J.M. Phillip. "Profiling emergent patterns of single-cell motility." *Advanced Science*. 2024. https://doi.org/10.1002/advs.202400918

N. Sivakumar*, C. Mura*, S.M. Peirce. "Innovations in Integrating Machine Learning and Agent-Based Modeling of Biomedical Systems." *Frontiers in Systems Biology | Multiscale Mechanistic Modeling.* 2022. https://doi.org/10.3389/fsysb.2022.959665

N. Sivakumar, H.V. Warner, S.M. Peirce, M.J. Lazzara. "A computational modeling approach for predicting multicell patterns based on signaling-induced differential adhesion." *PLOS Computational Biology*. 2022. https://doi.org/10.1371/journal.pcbi.1010701

H.V. Warner, **N. Sivakumar**, S.M. Peirce, M.J. Lazzara. "Multiscale computational models of cancer." *Current Opinion in Biomedical Engineering.* 2019. https://doi.org/10.1016/j.cobme.2019.11.002

**indicates co-first authorship*

Abstracts & Presentations

N. Sivakumar, C. Min, K. Choe, W. Beguelin, J.M. Phillip, F. Mac Gabhann. "Data-driven simulations elucidate how lymphocyte motility drives cell-cell interactions during the antibody response." ARCS Scholar Reception. October 23, 2025. DC. (Poster presentation).

N. Sivakumar, C. Min, K. Choe, W. Beguelin, J.M. Phillip, F. Mac Gabhann. "Multi-Scale Modeling Elucidates How Different Motility Impacts Germinal Center B-T Interactions." ARCS Scholar Reception. May 5, 2025. Baltimore, MD. (Poster presentation).

N. Sivakumar, C. Min, K. Choe, W. Beguelin, J.M. Phillip, F. Mac Gabhann. "Data-driven simulation to quantify the effect of lymphocyte motility on germinal center B-cell:T-cell interactions." Institute for Computational Medicine Retreat. December 10, 2024. Baltimore, MD. (Oral presentation).

L.S. Nidadavolu, D. Sosnowski, **N. Sivakumar**, D.A. Bennett, J.M. Phillip, B. Maher, J.D. Walston, E.S. Oh, P.M. Abadir. "Cardiovascular-Derived Cell-Free DNA: Associations With Frailty and Aging-Related Comorbidities.

Gerontological Society of America Annual Scientific Meeting. November 13-16, 2024. Seattle, WA. (Conference abstract). https://doi.org/10.1093/geroni/igae098.1722

N. Sivakumar, C. Min, K. Choe, W. Beguelin, J.M. Phillip, F. Mac Gabhann. "Multi-cellular simulations predict motility-driven B- and T-cell germinal center interactions." Annual Biomedical Engineering Society Conference. October 23-26, 2024. Baltimore, MD. (Oral presentation).

C. Min, K. Choe, **N. Sivakumar**, C. Xu, W. Beguelin, J.M. Phillip. "Dynamic behaviors of Ezh2 mutant B cell and interaction with follicular dendritic cell and T follicular helper cell within germinal centers." Annual Biomedical Engineering Society Conference. October 23-26, 2024. Baltimore, MD. (Poster presentation).

N. Sivakumar, C. Min, K. Choe, W. Beguelin, F. Mac Gabhann, J.M. Phillip. "Data-driven simulation elucidates role of lymphocyte motility in driving germinal center cell-cell interactions." Johns Hopkins Department of Medicine Research Retreat. February, 14, 2024. Baltimore, MD. (Poster presentation).

N. Sivakumar, C. Min, K. Choe, W. Beguelin, F. Mac Gabhann, J.M. Phillip. "Identification of differential motility patterns in germinal center light zone lymphocytes." Annual Biomedical Engineering Society Conference. October 11-14, 2023. Seattle, WA. (Poster presentation).

N. Sivakumar, D. Maity, C. Min, …, J.M. Phillip. "CaMI: A data-driven tool to analyze emergent spatiotemporal differences in single-cell motility." Annual Biomedical Engineering Society Conference. October 11-14, 2023. Seattle, WA. (Oral presentation).

N. Sivakumar, C. Chang-Chien, C. Zhang, P. Gu, Y. Li, Y. Yang, C.O. Taylor, J. Greenstein, C.E. Simpson. "A data-driven approach to improve patient risk stratification in pulmonary hypertension." Biomedical Engineering Design Day. May 1st, 2023. Baltimore, MD. (Oral presentation and poster).

N. Sivakumar, C. Chang-Chien, C. Zhang, P. Gu, Y. Li, Y. Yang, C.O. Taylor, J. Greenstein, C.E. Simpson. "A data-driven approach to define pathobiological classifications of pulmonary hypertension." Computational Medicine Night. March 27, 2023. Baltimore, MD. (Oral presentation).

N. Sivakumar, M. J. Lazzara, S.M. Peirce. "Hybrid, Multiscale Modeling of Signaling-Induced Pattern Formation in Multicell Spheroids." Annual Biomedical Engineering Society Conference. October 12-15, 2023. San Antonio, TX. (Oral presentation).

N. Sivakumar, M. J. Lazzara, S.M. Peirce. "A Computational Framework to Explore Multi-cell Spheroid Patterning with Synthetic Gene Circuits." World Congress of Biomechanics. July 10-14, 2023. Taipei, Taiwan. (Oral virtual presentation).

N. Sivakumar, M. J. Lazzara, S.M. Peirce. "Agent-Based Modeling of Multi-cell Spheroid Patterning using Synthetic Gene Circuits." Annual Biomedical Engineering Society Conference. October 6-9, 2021. Orlando, FL. (Poster presentation).

N. Sivakumar, S. M. Peirce. "Agent-Based Modeling and Machine Learning to Explore Multi-cell Spheroid Patterning." Beckman Symposium. August 5-7, 2021. Virtual Meeting. (Oral and poster presentation).

N. Sivakumar, J. Lipowski, G. Guadagni. "ABM of Covid-19 Spread at UVA." Global Infectious Diseases Institute Excellencein Undergraduate Research Award Symposium. January 21st, 2021. Virtual Meeting. (Oral presentation).

N. Sivakumar, Shayn M. Peirce, Matthew J. Lazzara. "Agent-Based Modeling for Designing Multi-Cell Patterns Using Synthetically-Engineered Gene Circuits." Annual Biomedical Engineering Society Conference. October 14-17, 2020. Virtual Meeting. (Poster presentation).

N. Sivakumar, H. V. Warner, M. J. Lazzara, S. M. Peirce. "Agent-Based Modeling of Self-Sorting Behaviors in Heterogeneous N-Cadherin and P-Cadherin Spheroids." Annual Biomedical Engineering Society Conference. October 16-19, 2019. Philadelphia, PA. (Poster presentation).