APS DBIO NEWSLETTER

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Life as an Early Career Biological Physicist

BY ORRIN SHINDELL

The DBIO virtual panel discussion this past September focused on the professional life of early career faculty working in biological physics. They discussed some issues of particular concern in interdisciplinary science along with other more general issues.

As biological physics uses techniques from physics to study biological problems, faculty often have appointments in biology or chemistry departments. The panel discussed how it can be good to have such close contact with biologists because they can help physicists discern which problems are relevant in biology. Being around biology or chemistry researchers can also lead to collaborations that help early career faculty be productive.

For biological physicists housed in physics departments, the opposite problem arises. Faculty need to convince their physics colleagues that their work is actually physics. The panel generally agreed the best way for biological physicists to persuade other physicists is to discuss the scientific significance of their work, employing the language physicists understand.

The panelists also discussed what to emphasize pre-tenure. They all suggested not to focus too much on tenure metrics, but instead on producing quality work that will be well regarded in the field. They all stressed that getting a tenure track position is an incredible opportunity to pursue exciting scientific work.

Tenure track faculty or those about to enter the job market, check out the recording for other great advice!

Navigating the Academic Job Market

On Monday, October 2, 2023, Executive Committee Chair-Elect Ajay Gopinathan moderated a panel called "Preparing for and navigating the academic job market: From grad students to faculty" with panelists U.C. Berkeley Professor Hernan Garcia, University of Pennsylvania Professor Andrea Liu, University of San Diego Professor Rae Robertson-Anderson, Syracuse University Professor Jennifer Ross, and University of Michigan Professor Suraj Shankar. Here is some of the advice they had to offer.

Gearing up in your early career:

"It [networking] is important, which is sometimes unfortunate… it tends to select against people who could contribute just as nicely to science, but it's the reality," said Garcia. "It's very important to be proactive." He recommended reaching out to professors at your school to ask if you can take them to lunch and talk about what you're doing, and finding a "challenge network" (from "Think Again" by Adam Grant) of people who will not just say that you're doing great, but who will critically evaluate your vision and your work so far. Networking, he said, is especially important for international students, who may not have the visibility of students who do graduate and postdoctoral work in the United States.

Tenure-track postings begin (July):

There is a whole range of schools on the spectrum between research-heavy (R1s and R2s) to teaching-heavy (community colleges or Teaching Professors at R1s) to in-between (liberal arts colleges, where you're expected to have a research program and focus on teaching). "The first question you have to ask yourself is, how passionate do you feel about teaching versus research? How important is doing high-powered research to you?" said Liu. "A lot of good jobs don't come with the resources to do a whole lot of research but come with very rewarding careers." Robertson-Anderson added that the size of the university might impact what schools you apply to. Would you like to be somewhere with one-on-one interaction and a small department or teaching a class of 500 students with a large department? Then look early, she said, even around September, for schools that fit your needs.

Preparing your application (with applications due between October and January):

The general advice from the panel was to tailor, tailor, tailor— even on things that you might not think the committee reads carefully, like the cover letter. Robertson-Anderson said, "If you have a blanket cover letter, it is very clear that you're not taking this job seriously." She even recommended tailoring your CV for teaching-focused versus research-focused positions. Garcia suggested having a standard application with "little areas of customization" based on connections that you might make with people at the university. "It takes time," he said— a few hours for every application to figure out those potential connections between you and a faculty member.

Liu summarized the research statement as "a vision that is really special to you." She continued, "All of your past experience is leading you to this point, and nobody else can have this vision," acknowledging that figuring out this vision takes a lot of work. Garcia added, "We want to hear about the exciting thing that you can do that nobody else can do— not aims of a grant." For him, the overriding question is: what does victory look like to you? "If I give you keys to a lab, three million dollars, and a few students, what happens?" he prompted. And finally, some second-hand advice from Princeton Professor Bill Bialek came via Garcia as he pointed out that "there is a difference between wanting to read somebody's papers and wanting to have that person down the hall… Otherwise they can just read your papers when you're somewhere else." Robertson-Anderson pointed out that your research statement, again, should be somewhat tailored to the institution, saying, "If you're going to be at a small university without a lot of infrastructure, you can't be proposing research that has a two million startup package…. And if you will get a two million startup package, you have to show it will be at that caliber." Finally, Liu pointed out that biological physics candidates could apply to many different departments, and suggested going to seminars in the department that you're applying for to get a feel for "how to communicate your research plans in a way that they appreciate".

According to Robertson-Anderson, the teaching statement should include your teaching philosophy, or what you want students to get out of your class— but again, tailor, tailor, tailor. Know if you're teaching undergrads versus graduate students, in small classes or large classes, so that you "know if you can implement your teaching philosophy in the classroom". If you don't have much teaching experience, Robertson-Anderson suggested looking at the large body of physics education research or going to the seminars on teaching physics at the APS March Meeting. "Show that… you have a genuine desire to educate students and some knowledge of the current understanding of teaching— flipped classrooms, active engagement." She suggested drawing on experiences tutoring, TAing, mentoring, or helping with outreach events if you have no experience teaching, finally warning candidates that "if teaching is the #1 criteria for tenure, then the teaching statement is the #1 thing they look at." A funny "don't" from moderator Gopinathan: don't ChatGPT your teaching statement!

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Non-academic careers, from the other side

This is a snippet of what was said at the November APS DBIO community engagement webinar. Check out the amazing Industry Mentorship Program for Physicists run by the American Physical Society at https://mentoring.aps.org/programs/impact for connections with students, early career physicists, and industrial physicists from any country.

Bryan Jackson, DE Shaw Research

I studied chemistry in undergraduate and graduate school at U.C. Berkeley. In graduate school, I was confident that I wanted to be an academic. But ultimately, I decided against it because I realized that to be an academic would mean that I would need to move anywhere in the country. That was untenable to me. There were only two places that I wanted to live— the Bay Area or New York City area— and the proposition of getting an offer from the universities there seemed quite low probability. So right after graduate school, I took a job just to make money, and it was the worst of all worlds: boring, and a lot of work. (Don't do it!) They say it's better to be lucky than good, and I certainly was very lucky in my (subsequent) career path. I went to a couple of job fairs and industry talks and brought resumes with me. Lucky for me, one of those resumes hit a little bit of pay dirt. Somebody from IBM Research called me and said, "Do you want to interview with my group?" I had never formally applied! The interviews went well and I worked there for a bit. Then, someone from DE Shaw Research reached out. I didn't know how challenging it was to get a job at DE Shaw Research. But things ended up going well. At DE Shaw Research, we build special-purpose supercomputers for drug discovery. We build from the ground up, in order to run molecular dynamics simulations of biomolecules and drug molecules that might bind to relevant proteins. I'm a program manager there. I focus on organizing the team, help the team decide what we're going to do, how much roughly things will cost, track things over time, and make sure everything gets done. So now I can scratch that research itch, but in industry. If I could go back in time, I would tell myself to: take more math classes, since I need linear algebra but never got a good grounding in it; take more risks in research as a graduate student to work on those high-impact projects that probably had the same likelihood of success as the lower-impact projects that you worked on; and to not be scared of trying new things in new disciplines that are very different from your training. In fact, what graduate school should teach you is that you can learn anything and that nothing is out of reach. For instance, machine learning is big right now. If you don't have any background on it, it doesn't matter, because you can learn enough to come up to speed and contribute. Also, by the way— when I review resumes, I consider postdocs to be continued graduate school work rather than added experience above academia.

Teddy Hay, Emano Metrics

I was never very career-oriented. In fact, I was a bit of a problem child in high school. I got some really bad grades in a couple classes. Luckily, I got into Reed College and really met high-quality, beautiful education. The physics department there was eye-opening and an excellent experience for me. Grades were just in the background, and there was very little career preparation, I think famously. I then dove in and tried new things. I've always been afraid of sticking with one job for my whole life. I got very interested in medicine and got EMT training, took a year off, worked in construction, traveled and taught in India, worked as a medical scribe, and finally got to a point where I realized that if I died with this level of understanding of physics, I would be dissatisfied. That was a driving force to go into graduate school at the University of Oregon with Professor Raghuveer Parthasarathy, where I did a ton of image processing and machine learning and really fell in love with machine learning. I knew this was a skill set I wanted to develop. So, I founded a company after graduating four years ago. This is probably the only time you'll hear machine learning applied to urination— we build machine learning technology that can measure urinary flow rate just from the sound of peeing. We sell in urology clinics. The first year of the startup involved getting the technology off the ground and getting a patent. We now have five full time people and customers in five different states. I'm now the CEO. My day-to-day changes all the time. I constantly dive into stuff I'm not very good at, but that needs to be one. Then someone else takes over and I'm off to something I'm not good at again. There's a lot of mythology about starting your own business that is just incorrect, so I'm happy to hear from you if you want to reach out with questions. If I could go back in time, I would tell myself to: trust my intuition, which sometimes runs counter to the unbiased scientific method that we learn to love; dive in and try new things frequently, since it's really no problem if you look stupid in front of a group of people as long as you analyze why you made the mistakes; be opportunistic; network, even if you're the kind of person I was in college who liked to do problem sets alone by reaching out to people you trust— and know that the people on this panel can even be the ones to connect you to some of the people you might trust; collaborate with others; and figure out what you love, what you're good at, what you're bad at, and what you hate, to figure out what's going to make you happy at the end of the day.

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Finally, the diversity statements are approached differently, but taken very seriously. Said Garcia, they are used to not just identify underrepresented minorities but also to find people that are committed to social justice and a diverse science environment. “Show you understand what the issues are, back them up with numbers and publications, and talk about what you’ve done in the past to help… and use the chance to show what you’d be excited doing over there— not just be welcoming in lab, but what are the other things you can see yourself being involved with,” said Garcia. Ross added that “you have to be authentic… it has to make sense for you.” Rubrics for diversity statements can be found online, such as https://ofew.berkeley.edu/recruitment/contributions-diversity/rubric-assessing-candidate-contributions-diversity-equity. Garcia warned, “Know that if you make things up, in chalk talks, we spend time on the diversity statement.” Ross agreed, saying that at Syracuse University, there is a “roundtable” for faculty hiring in which ask candidates questions about non-research aspects of the job. “If you don’t understand that Syracuse has double the national average of Latino students at the undergrad and graduate level, that’s an issue. We want the people that we’re hiring to care about these things because we care about these things,” said Ross. She did add that “you don’t need to know everything we offer.”

Interviews (between November and March):

There is a long list of about 25-40 people that are interviewed on Zoom, over the phone, or at a national conference and a short list of about 4-6 people that are taken to campus. The common theme in the advice for interviews? Practice.

For the first shorter interview, you are often given the questions asked in advance. These interviews are supposed to be succinct. “Prepare concise research summaries— for example, be prepared to summarize your research in two minutes, and practice that a lot,” advised Robertson-Anderson. However, “a red flag is when the response is 10 seconds long”.

The on-campus visit is a 1-2 day experience that includes: a job talk, a portfolio of what you’ve done and an outlook of what you’ll do at the colloquium level; a chalk talk, which highlights your vision for the future and how you’re going to achieve it, both in terms of research strategy and funding, and which may include a discussion of teaching and mentoring and service; sometimes a dedicated teaching demonstration (which is a definite for teaching-focused universities); and meetings with individual faculty, Deans, students, and the DEIJ committee. Shankar advised that you should “ask for your schedule and ask who will be in the chalk talk, so that you can prepare”. Similarly to what Garcia advised earlier on, Shankar advised again— look up the people you’ll be meeting, see what the potential connections are, and bring those up when you meet them. He added that the visit is “hectic and stressful” without many breaks, so that you should “take care of yourself, and hydrate and eat”. But don’t forget to be on your best behavior, said Ross, since “if you can’t not mistreat people while you’re here, we’re not going to hire you… It really only does take one bad apple. One bad person can derail a faculty meeting.” At the end of the visit, both Shankar and Robertson-Anderson advised sending thank you notes.

Finally, there’s a time and a place for every question. If you bring up questions about housing before you’ve been selected as a finalist, it will come off badly. Another “don’t” from the panel: don’t ask about salary yet!

Negotiation (between February and May):

If you get a job offer, prepare to do your homework in figuring out what you will need in order to pack up and move to the area— including, according to Garcia, the money required for a house and kids, if you’re planning to have them. According to Ross, the Dean has the money, and the Chair is a go-between. You have to justify why you will need money for this or that piece of equipment or for this much summer salary to the Chair, who will try to justify it to the Dean. If the Dean says that the ask is a non-starter, you have to figure out what you can trim— maybe figure out what equipment you can share with others, or if there’s a computing resource already available. If you have a two-body problem, Ross advises waiting until you have been picked as the top candidate to start negotiating for a position for your partner. “There are going to be some departments still to this day that might ding you for having a two-body issue,” she said. When Ross was negotiating, she had multiple offers to play off of each other, and had met women at Syracuse University in a different department that had been able to negotiate a spousal hire from whom she could get advice. But according to Gopinathan, “Coming up with a new offer is a time-consuming process, so you have to give the university an open opportunity to figure it out.”

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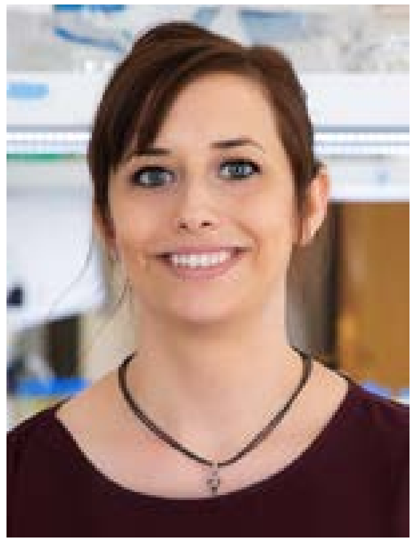
Cassandra Niman, Element Biosciences

I studied physics at UCSD in undergraduate and then went to the University of Oregon to do a Ph.D. in physics. I followed a professor there to Lund University in Sweden to study molecular motors and lipid bilayers using microscopy and microfluidics. Then, I did a postdoc back at UCSD building a fancy microscope and got more into applications. I started considering nonacademic jobs before my Ph.D. but said, “We’ll see how this goes.” I really liked my studies but mid-way thought that I didn’t want to pursue being a professor, and this was solidified in postdoc. So I did enough of the postdoctoral project to feel okay about it and then jumped ship to industry. First, I went from my postdoc to Nikon, who makes microscopes, doing customer support and sales and training. It was difficult to get an interview, but I knew microscope representatives because they had worked on my microscopes and they had then asked if I was interested in a position. Many people in that position didn’t have experience, but Nikon trains you really well, so it’s a good opportunity to expand your network and even include customers as part of your network. One of my co-workers is a former customer. A big part of getting a job is networking— don’t e afraid to reach out to people that you haven’t talked to in five years. If they just ignore your message, what’s the worst that can happen? Now I’m at a startup called Element Biosciences, which makes DNA sequencers. My role changes a lot from day to day as it is a startup. I work on testing equipment, troubleshooting, coordinating a lot of different engineers and scientists to make sure we’re meeting the goals; in fact, my role is now a lot of project management, making sure we’re getting all the small details right for implementing a larger project goal. If I could go back in time, I would tell myself that all the time you spend on soft skills in your Ph.D. is really valuable. A lot of people don’t get the opportunity that we get to work on those things, be it presentations or lab management. I had to do tasks during my Ph.D. that I thought were holding me back from doing research, but now that I’m practiced at those tasks (like coordinating people), I can do them quickly and get to the more interesting parts.

Naghmeh Rezaei, Google

I did physics in undergraduate and graduate school, first in Iran and then at Simon Fraser University in Canada. I first researched solid state physics and superconductors and then learned about applications of physics in biology. I met Professor Nancy Forde at Simon Fraser University and joined her group, where I studied protein structures and folding dynamics for my Ph.D. For the entirety of my graduate school, I was considering the academic direction until the last year when I was writing my thesis. Then, I started to have a fascination for biotechnology and industry. I was writing my thesis remotely from the Bay Area and going to talks at Stanford University and U.C. Berkeley and going to hackathons hosted by companies. I wanted to move to industry and stay there for a while to see if I wanted to switch back. (Eventually, I found common ground being in industry research.) I had to figure out what role I wanted, though. I had worked on proteins; I knew a little bit of biology, machine learning, computer vision, and physics. It was challenging to figure out which companies to target. I talked to a lot of people who had a lot of different trajectories and found out about data science when it was relatively newer. That started a new era for me— it was a big scary task, but I knew what direction to take my career in. I learned about a (now-defunct) seven-week Insight Data Science Fellowship program that expands your network, helps to fill in knowledge gaps, introduces you to soon-to-be data scientists, and pairs you with a startup. After that, I had a lot of interviews. The interviewing process is nonlinear and varies from company to company. I ended up with four offers, but then reached out to Illumina and said that I was really interested in one of their roles as a founding data scientist. They really expedited the process for me and I ended up getting the job. That was my first nonacademic industry job. Later, I worked on the FitBit R&D team, which was acquired by Google. I’m now a Google research scientist on their customer health and artificial intelligence research team. I mostly work on features on the applications side rather than the wearables side, mostly working on algorithms. The problems are pretty ambiguous, and we often collaborate with larger teams to integrate solutions on the research side with their work. I still contribute to the scientific community as part of this team by publishing with academics and even mentoring student researchers. If I could go back in time, I would give myself two pieces of advice. First of all, a lot of the time in academia, when we work on prototyping a solution, we don’t think about how the solution can fit into a more complex system. I would have learned about best practices in industry and adopted those early on, e.g. version control and postmortems, either from reading about them or experiencing an industry internship. But also, I would have told myself— always be honest with what direction you want to go in. It’s okay to change your mind and your path, as we always grow and situations always change. You might even have to revisit the question of what you want to do every few months.

Meet the winner of the APS Maria Goeppert Mayer Award!



Alison Patteson, Syracuse University

CONTRIBUTION TO BIOPHYSICS COMMUNITY:

APS President Robert Rosner cites Patteson's important research contributions in characterizing the physics of living systems, including demonstrating how mechanics influences the collective behavior of bacteria and how intermediate filaments in a cell's cytoskeleton impact its mechanics, migration and signaling.

WHAT GOT YOU INTERESTED IN BIOPHYSICS?

I suppose I got interested in biophysics rather late. I was a few years into my PhD in a Mechanical Engineering Department, when I became interested in biophysics. That was when I started working on the dynamics of swimming bacteria and became interested in how cells mechanically couple to their environment and 'read-out' information about it. Answering these types of questions can tell you about the molecular machines cells use to move and generate force, which has implications for their biological functions.

WHAT DO YOU HOPE TO DO NEXT?

In terms of research, I am really excited to pursue questions about how cells collectively navigate complex environments, such as mazes. I'm also excited about expanding microfabrication and engineering techniques in our group to investigate living cells.

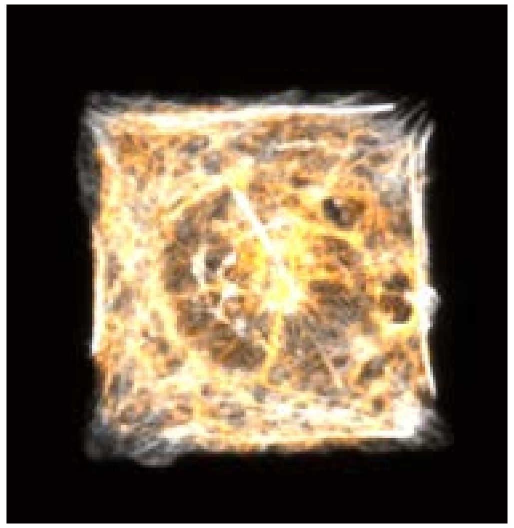
I also look forward to continuing to work with and recruit undergraduate and high school students in our lab.

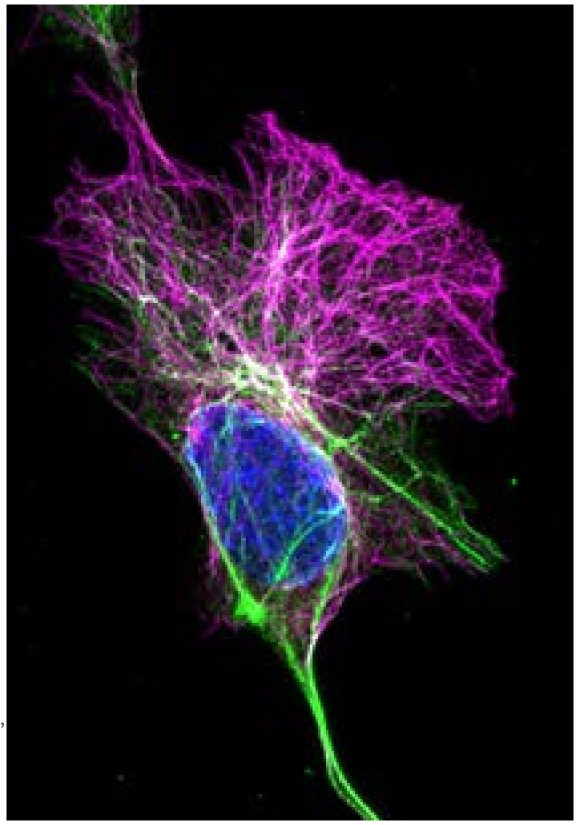
WHAT'S YOUR FAVORITE SCIENCE PAPER AND WHY?

It is hard to pick just one, but among the favorites are:

Ł.Suprewicz*, M.Swoger*, S. Gupta, E. Piktel, F.J. Byfield, D.V. Iwamoto, D.A. Germann+, J. Reszeć, N. Marcińczyk, P.A. Janmey, J.M. Schwarz, R. Bucki, A.E. Patteson†, Extracellular vimentin as a target against SARS-CoV-2 host cell invasion. Small 2105640 (2021).

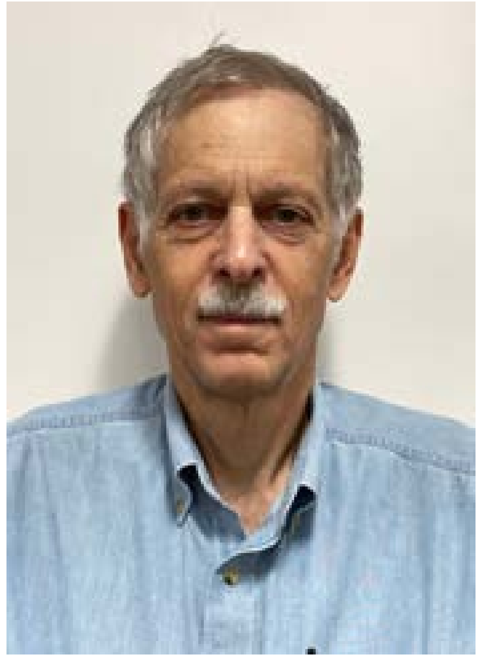
This paper came about after the pandemic and was an exciting multi-group effort. My lab had shut down due to COVID after just opening a year before. Working on a COVID-related project gave me motivation, and I had flexibility to pursue it because I was still in a new stage.





Pictures from the lab attached show mouse embryonic fibroblasts stained from the vimentin cytoskeleton.

Meet the winner of the Max Delbruck Award!



Eric Siggia, Rockefeller University

CONTRIBUTION TO BIOPHYSICS COMMUNITY:

My move to Rockefeller from Cornell in the late 90's coincided with a shift to biological problems, specifically single molecule mechanics of DNA, protein trafficking by live cell imaging, bioinformatics of gene regulation, the cell cycle dynamics in budding yeast, and embryonic stem cell models of development. Most recently the mathematics of dynamical systems was applied to classify fate transitions in cells or self-organizing cellular aggregates. Though these problems look very different to a biologist, quantitative theory was possible and a physics perspective and technology brought new insights. Experiments driven by theory are essential and I was fortunate to work with labs for whom collaboration was bi-directional, and who welcomed many physics trainees who made the jump from theory to experiment.

WHAT GOT YOU INTERESTED IN BIOPHYSICS?

I switched fields in the mid-1990's since the graduate students at Cornell were facing no jobs in the profession and just getting their PhD for credentialing. Too many papers were models of models. Moving to Rockefeller allowed integration into a good biology department. At the present time, there are lots of interesting physics problems— condensed matter problems in the quantum domain, quantum computing, atom simulations of Hubbard models and such— so perhaps today I would not have jumped ship.

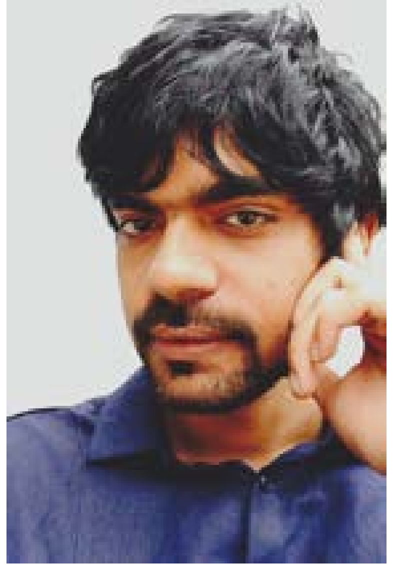
WHAT DO YOU HOPE TO DO NEXT?

That is a long story. I plan to continue using methods in "Geometry of gene regulatory dynamics" https://www.pnas.org/doi/10.1073/pnas.2109729118 on other stem cell and developmental problems, perhaps indulge in data reduction methods in neuroscience, with a view to proposing low dimensional models.

WHAT'S YOUR FAVORITE SCIENCE PAPER AND WHY?

Papers in the biophysics realm that I most admire are Berg-Purcell ("Physics of chemoreception"), Delbruck-Luria ("Mutations of Bacteria from Virus Sensitivity to Virus Resistance") and Hodgkin-Huxley axons ("A quantitative description of membrane current and its application to conduction and excitation in nerve"). Hardly an imaginative assortment! People who I knew, could understand, but whom I could never emulate would include Phil Anderson and Pierre-Gilles de Gennes.

Meet the Early Career Award in Biological Physics Winner!



Shiladitya Banerjee, Carnegie Mellon University

CONTRIBUTION TO BIOPHYSICS COMMUNITY:

I have had the privilege of working alongside an outstanding team of researchers and training a diverse cohort of students and postdocs, each bringing unique skillsets to our collective endeavors. Our main contributions have been formulating theory and computational models to understand how the internal structures and machineries of a living cell collectively influence cellular movement, physiological functions, and communication with other cells. The morphology and architecture of cells hold profound significance in shaping their physiological processes and mechanical responses. Utilizing theoretical concepts rooted in soft matter and statistical physics, we have constructed predictive models for cellular growth and self-replication, tissue morphogenesis and the dynamics of cellular adaptations to environmental changes. Through these efforts, our contributions have elucidated the adaptive mechanical behaviors of living cells and tissues, mechanics of epithelial wound healing, self-organizations in cytoskeletal systems, physical rules of cell competition, quantitative principles of cell size and shape regulation in bacteria. These studies exemplify a productive dialogue between theory and experiments, where our theoretical models, grounded in physics, have provided new mechanistic insights into complex biological phenomena.

WHAT GOT YOU INTERESTED IN BIOPHYSICS?

My interest in biophysics sparked during the early stages of my PhD studies in Physics. My PhD advisor, Cristina Marchetti, introduced me to the fascinating physics of active matter systems, which was a relatively new field at that time. Learning about the physics of active matter ignited my interest in collective behavior in living systems and I found myself increasingly drawn to quantitative problems in biology. The challenge to come up with new physical frameworks to understand the dynamics of living systems captured my scientific interests.

WHAT DO YOU HOPE TO DO NEXT?

Our current work is focused on understanding the physical behaviors of living systems in dynamic fluctuating environments. We are working on developing quantitative theories and data-driven models to uncover the control principles for cellular adaptive response under energy constraints and resource limitations, across diverse living systems and conditions.

WHAT'S YOUR FAVORITE SCIENCE PAPER AND WHY?

Choosing a single favorite science paper proved to be quite challenging – there have been so many that have inspired me! However, a recent paper from Manu Prakash's group, Mathijssen et al., "Collective intercellular communication through ultra-fast hydrodynamic trigger waves", Nature (2019), stands out. This paper reported the discovery of mechanical communication between protists through ultra-fast contraction waves generated by each protist cell. I appreciate this work because it exemplifies how fundamental physics concepts, like hydrodynamic interactions and phase transitions, can explain the emergence of collective long-range communication in a living system. It's a paper I have not only enjoyed reading but also found to be an excellent topic for my graduate course in Biological Physics, particularly to explain how various fields of physics and mathematics (fluid dynamics, statistical physics, percolation theory) often synergize to lead to new discoveries in biology.

Reflecting on my group's contributions, one that readily comes to mind is: Ojkic et al "Surface-to-volume scaling and aspect ratio preservation in rod-shaped bacteria", eLife (2019). Here we discovered an important new scaling law for bacterial growth and morphogenesis, which we explained through a model that couples cell elongation and the division protein synthesis. It is a great example of how meta-analysis of existing data can generate new insights into the functioning of a living system, with the potential for generalizations to larger classes of organisms.

Meet the new APS Fellows!

Sarah Veatch, University of Michigan

CONTRIBUTION TO BIOPHYSICS COMMUNITY:

I was one of several researchers that first characterized liquid-liquid phase separation in lipid bilayer membranes, showing that thermodynamically robust phase diagrams explain much of the behaviors observed in these systems, and pointing out the interesting physics that happens when composition and temperature is tuned near a critical point. Soon after methods were described to make bilayer vesicles from cell plasma membranes, I noticed that cells somehow biologically tuned their plasma membrane to be close to a miscibility critical point, suggesting that intact cells exploit critical behavior to accomplish biological functions. More recently, I have shifted to working more with intact cell plasma membranes, where we can observe consequences of this unique biological tuning. We have now shown that this phase transition impacts biochemistry happening in and near membranes, by tuning the local concentration of membrane proteins and lipids involved in cell signaling.

WHAT GOT YOU INTERESTED IN BIOPHYSICS?

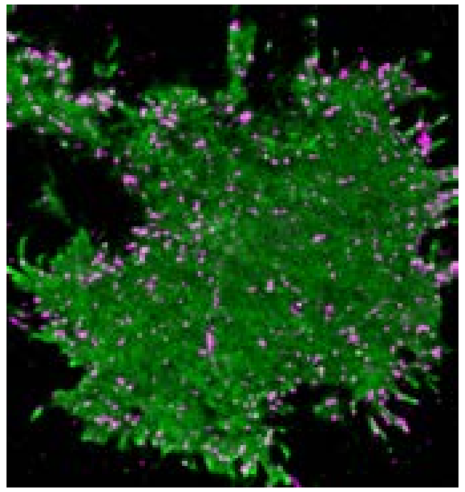
As an undergraduate physics student at MIT required to do undergraduate research, I found myself in the lab of Rai Weiss, who was a founding member of the LIGO collaboration looking for evidence for gravity waves. At that time, their instruments were just about to come on-line, and day to day work in the lab (for me at least) involved building and testing instruments to measure environmental noise, which I loved. This experience showed me that I loved the process of experimental physics but also that I wanted to do smaller science, where I could have control over a project from start to finish. Once in graduate school at the University of Washington, I quickly was drawn to biophysics because it let me tinker while also treading new ground, answer answering questions that I could imagine one day being connected to medicine. I got hooked when I had the opportunity to work with Sarah Keller, an inspiring scientist who had just started at the University of Washington where I was enrolled. With Sarah, I got excited about a specific biophysical question and more generally realized how ready biology was for physical exploration.

WHAT DO YOU HOPE TO DO NEXT?

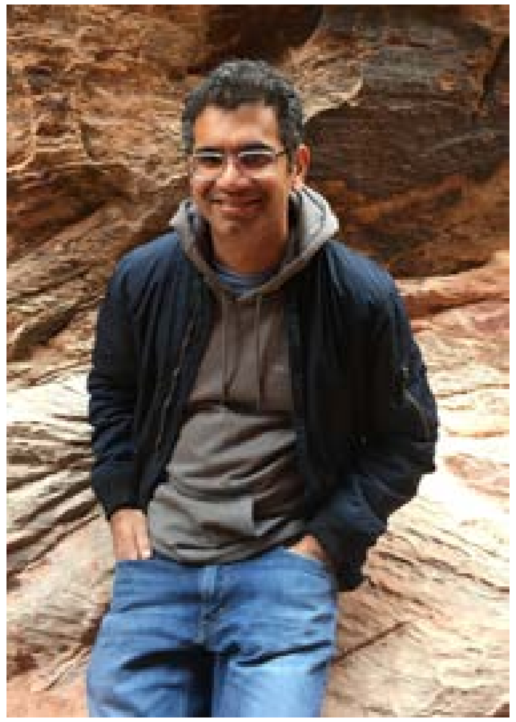
There is a lot of excitement about liquid-liquid phase transitions driven by proteins and nucleic acids in biology now, and one area I am excited about is how membranes can couple to these biopolymers to establish structures at membranes. I am guessing that we will find that many structures we already know about at the plasma membrane can be described using this type of formalism, which exploits unique features of both membrane and biopolymer interactions. I've also gotten excited about less thought-about consequences of phase coexistence, such as the constraints imposed on the chemical activity of components. Since many membrane proteins can be regulated by hydrophobic binding partners, the ability to tune the chemical activity of through the phase transition could regulate many proteins at once.

WHAT'S YOUR FAVORITE SCIENCE PAPER AND WHY?

For this I probably have to go back to "Lipid rafts reconstituted in model membranes" (BJ 80(3):1417 (2001)). Seeing Luis Bagatolli present this work at a Biophysical Society meeting was a big part of my starting work in this area, and the paper stands the test of time. I also had the opportunity to dig back into Singer and Nicholson's "The Fuild Mosaic model of the structure of cell membranes" (Science 175(4023):720 (1972)), a really great review that shaped a lot of thought in my field. They took a very physics-minded approach to argue for a plausible model for membranes, at a time when there were still arguments over its fundamental bilayer structure, and successfully crafted arguments that were highly relevant to a broad scientific audience. Many of the specific biological predictions they discussed have ended up being more complicated than they predicted, but the foundation which they built remains solid because it was drawn from basic physical principles.



Meet the new APS Fellows!



Pankaj Mehta, Boston University

CONTRIBUTION TO BIOPHYSICS COMMUNITY

I am proud, first and foremost, of the students and postdocs that have come through the group. Training thoughtful and engaged scientists from diverse backgrounds is perhaps the greatest contribution our group has made to the biophysics community. This is true both in academia but also in industry. In terms of research, I really enjoy the creative ways our group has recast interesting biological problems in the language of statistical mechanics. I think our papers have impacted the way people think about a number of topics including the energetic costs of cellular computation, the gene networks underlying cell identity, and microbial ecology. I have also enjoyed organizing and lecturing at workshops and schools to exchange ideas and help the biophysics community learn from each other.

WHAT GOT YOU INTERESTED IN BIOPHYSICS?

Initially, I loved mathematics and wanted to be a string theorist. However, during my first year of graduate school at Rutgers, I realized that I was not swayed by many of the arguments of string theory -- for example, that mathematical consistency required our world to be eleven dimensions. For this reason, I did my Ph.D. in theoretical condensed matter physics working on exactly solvable one-dimensional models. I had a wonderful and supportive Ph.D advisor, Natan Andrei, but again, the work was very abstract and at this point I felt that maybe physics was not the career choice for me. Towards the end of graduate school, I met Anirvan Sengupta, who had just been hired as an Assistant Professor. I took a biophysics course from him and it just opened my eyes. Here were all these unsolved problems in biology that we could use ideas from statistical physics to try to tackle. Anirvan is one of the most creative, enthusiastic, and interesting scientists I know and with his encouragement, I switched fields and took a postdoctoral position with Ned Wingreen and Curt Callan at Princeton. At this point, I was still not sure I wanted to stay in physics but working with Ned was such a wonderful experience, both intellectually and personally, that I knew that I wanted to do this for the rest of my life if I had the opportunity.

WHAT DO YOU HOPE TO DO NEXT?

I am really interested in two things. First, can we develop a theory of eco-evolutionary dynamics? Right now, I think most attempts at this start with population genetics, and then add a little bit of ecology. Philosophically, we want to do the opposite: start with a very rich ecological model and then add evolution to it. It's an ambitious project but I think we have some good ideas. There is also a very fun community developing around this goal that I am happy to be a part of. The second major thing we are thinking about is can we develop a theory of cell identity and development that integrates gene expression, signaling, and mechanics in space and time. While there exists very nice work theoretical thinking about these three areas separately, we currently lack a unified framework that can deal with all this biological complexity on equal footing.

WHAT'S YOUR FAVORITE SCIENCE PAPER AND WHY?

My favorite science paper (or papers) are two classics by John Hopfield:

1. Hopfield, John J. "Neural networks and physical systems with emergent collective computational abilities." Proceedings of the national academy of sciences 79.8 (1982): 2554-2558.

2. Hopfield, John J. "Kinetic proofreading: a new mechanism for reducing errors in biosynthetic processes requiring high specificity." Proceedings of the National Academy of Sciences 71.10 (1974): 4135-4139.

These papers set the gold standard for theory in biology. In both these papers, Hopfield uses simple models to illustrate universal ideas: that attractors in neural networks can emerge from simple rules and that cells can consume energy to increase the fidelity of information transmission. I think the real achievement of these papers is how they provide you with a simple but rigorous language for thinking about complex processes in biological systems.

Meet the new APS Fellows!

Laura Finzi, Emory University

CONTRIBUTION TO BIOPHYSICS COMMUNITY

(Laura Finzi was awarded the APS Fellowship for pioneering work on magnetic tweezers to resolve the difference between full polymer elastic theory and the simplifying freely jointed chain model and to demonstrate the key role of DNA supercoiling in transcription regulation, and for using tethered particle motion to study genetic switches. Taken from the APS website.)

Just like everyone else, I benefit from meetings, forums, workshops and the infrastructure provided by scientific societies. Therefore, I feel compelled to give back with professional service. I have been a member of APS and the Biophysical Society (BPS) for many years. Through the years I have served BPS in many roles. For example, I have been a member of Council and the Executive Board, and the Program and the Nomination committees. I helped start the "Nanoscale Approaches to Biology" and the "Single-Molecule Forces, Manipulation and Visualization" subgroups of the Biophysical Society (now thriving). I served on the editorial board of the Biophysical Journal and have been serving for several years on the editorial board of Biophysical Reviews. Throughout my career, I have organized local and regional meetings as well as networking and brainstorming opportunities for scientific initiatives. I believe in education and mentoring in ways that foster inclusive and supportive environments, while promoting talented investigators and ground-breaking research. I am especially passionate about eliminating the gender barrier in science, biophysics, and physics.

WHAT GOT YOU INTERESTED IN BIOPHYSICS?

I did not know much about biophysics before joining the group of Carlos Bustamante, my Ph.D. advisor. In his lab I became intrigued with optics, DNA, and polymer physics. I had the opportunity to participate in, and contribute to, the renaissance of optical methods and microscopy that confocal microscopy and single-molecule methods brought about, and I assembled a very special microscope on my own without much prior experience in instrumentation. That was thrilling! At every turn in my career, I have had the good fortune of finding novel paths of scientific inquiry, and I have always been fascinated by the physics that underlies Nature.

WHAT DO YOU HOPE TO DO NEXT?

I have accepted an endowed chair position in the Department of Physics & Astronomy with an affiliation in the Bioengineering Department at Clemson University to help develop their new program in Medical Biophysics. It is a wonderful opportunity professionally and welcome news in the field of Biophysics. Some Physics departments view Biophysics with skepticism, and a common sentiment is that Biophysics belongs in medical schools. It is quite exciting that the department of Physics and Astronomy at Clemson dedicated an endowed chair to Medical Biophysics, and I am ready to get to work!

WHAT'S YOUR FAVORITE SCIENCE PAPER AND WHY?

This is a very difficult question. Obviously, there are many papers that have become classics in particular fields and for the larger scientific community, and many have inspired me to either take certain directions of investigation, or to become a bold and independent investigator. In this vein, two papers by the groups of two exceptional scientists have been very important paper to me. The first, is "Supercoiling facilitates lac operator-repressor-pseudo-operator interactions" by P A Whitson, W T Hsieh, R D Wells, K S Matthews, published in 1987 in the Journal of Biological Chemistry vol 262(11):4943-6, PMID: 3549713. It spurred my interest in DNA supercoiling and provided me with role models of superb female scholars and academicians. The principal investigator, Stewart Memorial Professor Emeritus Kathleen Shive Matthews from Rice University, has been a pillar in the investigation of protein-DNA interactions involved in regulating gene expression, while the first author, Peggy A. Whitson, went on to a brilliant career and is a pluri-awarded former NASA astronaut. The second paper is "Optical alignment and spinning of laser-trapped microscopic particles." published in Nature in 1998. The PI, Halina Rubinsztein-Dunlop from the University of Queensland, is a fellow of the Australian Academy of Science and Officer of the Order of Australia. She led pioneering research in atom optics, laser micro-manipulation using optical tweezers, laser enhanced ionization spectroscopy, biophysics, and quantum physics. This paper was most influential at a turning point in my career when I returned to focus on single-molecule biophysics and established lively collaborations with colleagues across Europe, which resulted in three papers (J. Photochem. Photobiol., 2001; Eur. Biophys. J, 2005; EMBO Reports, 2005) and led to one of the main lines of research that distinguish my group on the physics of transcription and transcriptional regulation.

Meet the new APS Fellows!

Vernita Gordon, University of Texas at Austin

CONTRIBUTION TO BIOPHYSICS COMMUNITY

We've taken ideas from soft-matter physics and worked to understand how they interplay with biology in the specific case of bacterial biofilms. Biofilms are communities of interacting microbes that are embedded in a matrix of extracellular polymers and proteins. This matrix confers upon the system physical properties that are not present for an equivalent population of microbes in a free-swimming or suspended, non-biofilm state. These physical properties include the viscoelastic mechanics of the biofilm cells cohering to each other and attaching to an external surface, and the spatial structure arising from cells being held in position. We want to understand how these things are linked to the biology of biofilm development and growth, and the disease properties of biofilms such as antibiotic tolerance and evasion of the immune system.

WHAT GOT YOU INTERESTED IN BIOPHYSICS?

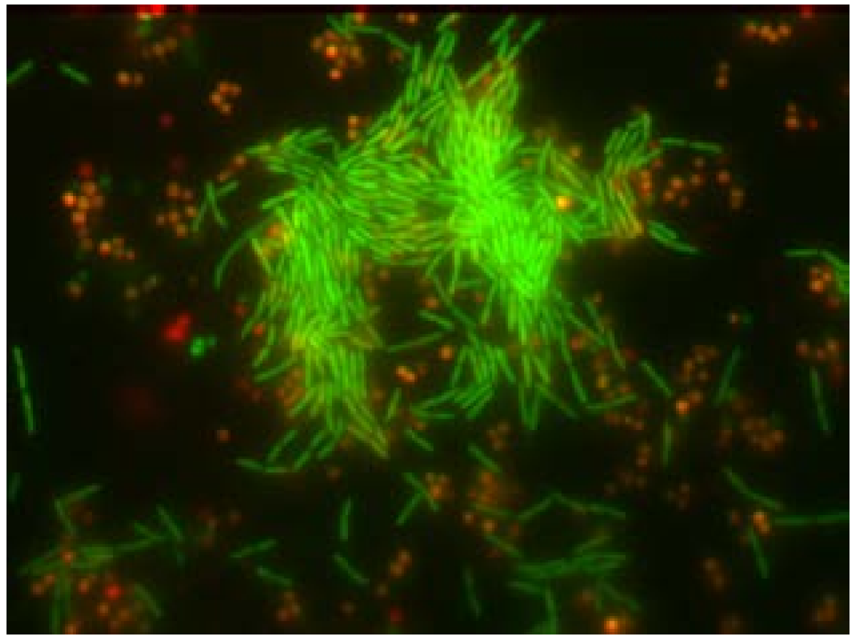
I found biophysics exciting in a way that I didn't non-biological physics. This was an irrational, emotional attraction, and I don't know why I felt that way any more than I know why I like carrot cake and Doritos. Biofilms specifically I found an attractive topic to study because I needed to know that the work I was doing could one day make people's lives better. The health implications of biofilm infections, which occur in a wide range of scenarios and are very costly and difficult to treat, made them a good case for this.

WHAT DO YOU HOPE TO DO NEXT?

I really want to grow my group's work to have direct real-world impact instead of only publishing academic papers with a long-term view toward real-world impact. I've realized that I really don't know how to do this, and I need help (and patience!) from a lot of other people who do know how to have real-world impact.

WHAT'S YOUR FAVORITE SCIENCE PAPER AND WHY?

I have no idea. I hate questions like this. There are a lot of good papers, and they are good in different ways, and sometimes I am pulled toward one and sometimes toward another. This is like when people ask me what my favorite book or movie or song is. I have no idea how to answer this category of question, and even if I could my answer would be different on the day this is published than it is today.



Pictures are of a seeded Pseudomonas cluster in a field of Staph at 6 hours after placement of Pseudomonas cells. Pseudomonas are shown in green and Staph in red.

And congratulations to many more...

APS Fellow Kerwyn Casey Huang, Stanford University

"Understanding how cells grow and divide has profound impacts on basic science, biotech, and medicine. Despite recent advances in molecular biology and biochemistry, a central challenge remains: bridging the nanometer-scale activities of proteins and the construction of entire cells. Although the mechanisms of bacterial proliferation have been a major focus of research for over a century, it has remained difficult to determine how cellular structure and organization are dynamically controlled due to the central—yet neglected—importance of physical factors." -- from his website

The fellowship was awarded for elucidating the biophysical properties of the Gram-negative bacterial cell envelope, for highlighting the pivotal role of the outer membrane in conferring stiffness, and for overturning the paradigm of the cell wall as the sole determinant of mechanical stability.

Outstanding Doctoral Thesis Research Winner Diederik Laman Trip, Delft University of Technology

For discovering how temperature constrains and drives cell replication and revealing that cells can cooperatively survive in extreme heat and cold, revising accepted views of temperature-dependent cell growth by integrating single-cell and genome-scale experiments with dynamical systems theory.

Diederik Laman Trip is currently a postdoctoral researcher at the ETH Zürich, working with Prof. Pedro Beltrao on the tissue-specificity of protein-protein interactions. In 2022, he earned his Ph.D. cum laude from the Kavli Institute of Nanoscience at Delft University of Technology, where he worked with Prof. Hyun Youk to study the fundamental principles that govern the viability and replication of budding yeast at extreme temperatures.

Calendar of upcoming events

DEC

12

From classrooms to community: Nurturing future biophysicists through outreach

When high school or undergraduate students or the public discuss Physics, it's rare for biological physics to be a part of those conversations. This could result in a lack of future biophysics researchers, enthusiasts, or public speakers. However, this situation can be addressed by providing more exposure to this exciting field. By incorporating outreach and courses at these educational levels, we can introduce students and the public to the captivating world of biological physics. Our panel will share their experiences initiating biophysics outreach and teaching programs at their respective institutions. Join us as we explore how you can establish and contribute to similar programs at your institution.

JAN

17

APS March Meeting: Early Bird Registration

MAR

3-8

APS March Meeting in Minneapolis

The American Physical Society's March Meeting 2024 is a scientific research conference convening 13,000 physicists and students from around the world to connect and collaborate across academia, industry, and major labs. Join us in 2024 for an extra special week as we celebrate the 125th anniversary of APS.

Unrelatedly, please visit APS DBIO Engage, Workshops and Networking at https://engage.aps.org/dbio/resources/workshops-networking to see the upcoming schedule for community engagement webinars. There, you can register for the webinar at left.