Journey of a Young Investigator

IndiaBioscience

This collection celebrates the stories of eighteen of the young investigators attending YIM 2020. Hailing from widely different backgrounds and research interests, these researchers are united in their passion for science and in their ability to persist in spite of challenges in their path. We hope that these stories will serve as inspiration for their peers as well as for those hoping to launch their scientific careers in India in the near future

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Part 1

New Beginnings

MY 'INSPIRE'd Journey

Vaishnavi Ananthanarayanan

Armed with a dual degree in Biological Sciences and Computer Science from BITS, Pilani (Goa Campus) and a fruitful stint at Microsoft Research India, I set out to do my PhD at the Max Planck Institute of Molecular Cell Biology and Genetics, Dresden, in 2010. I had great fun working towards my PhD and realized I loved cytoskeleton biophysics. I was part of a wonderful lab, made friends for life, and had an amazing PhD mentor who let me write and submit my thesis from home in India. It was during this time that I learnt of the various funding schemes available to early career researchers in India.

The DST-INSPIRE Faculty Scheme particularly caught my eye since I was eligible to apply – "It provides attractive opportunities to young achievers (in the age group of 27–32 years) for developing independent scientific profiles and intends helping them emerge as S&T leaders in the long term." It was quite a revelation and a moment of epiphany to me that I could, in fact, embark on an independent research track without (what I had thought was mandatory) postdoctoral training.

What logically followed was a simple proposal application on DST's online INSPIRE portal. After a rather painless round of interviews, and a wait of

a couple of months, I received formal confirmation of having been awarded the INSPIRE Faculty Award.

I had applied through the regular route and did not already have a host institute in mind. But fortuitously, I had been selected to attend the Young Investigators' Meeting 2014 which was to be held only a couple of weeks following the announcement of my award. True to its USP, the YIM gave me the opportunity to interact with several institute representatives and present my 5-year research plan as a part of the INSPIRE Faculty Award.

A direct result of my YIM experience was an offer from a soon-to-be independent Centre at the Indian Institute of Science (IISc), Bengaluru, which was then only a PhD programme – the Bioengineering Programme. G. K. Ananthasuresh and Sandhya S. Visweswariah, who head the Centre, chose to take a gamble and support a fresh PhD Graduate. A fellow INSPIRE Faculty Fellow and I were given infrastructure and administrative support, and most importantly, complete research independence.

While I was forewarned by several well-meaning scientists about multiple issues including the differences between doing science abroad vs in India, my inexperience due to lack of postdoctoral training, limited exposure to the realities of pursuing research in India, and a host of other scientific and non-scientific issues, my (naïve) optimism did not wane. I sought to develop a research program centred around quantitative cell biology of the cytoskeleton, combining my expertise in microscopy, image processing and analysis, cell biology, and biophysics. I thus joined IISc in June 2014 with little more than the INSPIRE Faculty Award and a healthy dose of enthusiasm.

While I had proposed to use mammalian cell culture models in my research, I quickly understood setting up the cell culture lab in our Centre would take more time than I had bargained for. Hence my trusty friend, the fission yeast, which I had worked with in my PhD, was called upon. Preliminary experiments were done, and two other grants were applied to, both of which relied on the fission yeast model system. Thankfully, both of the grants (the Innovative Young Biotechnologist Award from DBT, and the Early Career Research Award from SERB) were funded.

I was glad to be doing a majority of the experiments alongside my first students. This is where the INSPIRE Award was a boon – while it gave me a shot at independent research at the level of an Assistant Professor, I was not required to fulfil the obligations of an Assistant Professor in her formative years, be it in faculty meetings, comprehensive exam committees or other administrative responsibilities. While this might be seen by some as a disadvantage, I was genuinely happy—I was free to concentrate solely on my research.

The first year zoomed past with setting up the lab, acquiring more funds, and performing the first set of experiments proposed. The second and third years were productive, with one review article and three research articles from my independent lab. On my third work anniversary as an INSPIRE Fellow, I gave a chalk talk following my formal application and presentation for an Assistant Professor position at the Centre for BioSystems Science and Engineering (BSSE), IISc. Finally, in October 2017, I officially joined BSSE as an Assistant Professor.

Of course, I made several mistakes (and still do), but the lessons I learnt would most likely be hard to come by being a postdoctoral fellow in a lab that has been established already. There were no illusions about doing science in an Indian setting and I am grateful to have had first-hand experience early on in my career. With the INSPIRE Award, I knew there were no guarantees regarding my future prospects at IISc or elsewhere, but I valued the opportunity to work on something that genuinely interested me.

For potential applicants for the INSPIRE Faculty Award, I have the following pieces of advice from my limited wisdom:

- *Apply as soon as you know you would like to pursue an independent research career:* The INSPIRE Faculty Award is ideal for candidates who are within 2 years of their post-doctoral training. Any longer, and the candidate is already eligible to apply for regular positions, defeating the INSPIRE Faculty Award's purpose.
- *Know what is expected of you:* Institutes/departments differ in their

policies when hosting INSPIRE Faculty Fellows. Be sure to understand what is offered to you as a Faculty Fellow and what is expected of you.

- *Do not hesitate to ask for help:* There is often a misconception that as the leader of a research group, one has to be independent in the truest sense and not rely on help from peers or seniors. This couldn't be further from the truth. Reach out to people in your Department or Institute for sharing of equipment, consumables, or even just for advice. I am thankful to a number of people within IISc, across the country and abroad for having come to my rescue when I was in a pinch.

- *Be open-minded :* One might be required to do everything from reformulating the original research question due to unforeseen circumstances, to meeting changing expectations for a regular position at the host institute. Most of these issues are rather fluid, and at the risk of sounding clichéd, take things one day at a time.

While there are several structural issues that still need to be sorted with the INSPIRE Faculty Fellowship (the most prevalent among these being late disbursal of funds), I am not aware of any other fellowship that gives a newly-minted PhD Graduate the chance to head her own lab and to define her own research questions. I, for one, have benefitted immensely from 'going solo' just after my PhD.

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Postdoc in India
A Different Perspective

Megha Kumar

I am a developmental biologist and my happiest moments in the lab are when I am watching embryos develop with time. Embryos are such perfect creations, beautiful, intricate and dynamic. The communication between cells in the embryo is at its best and the most intriguing aspect of this field is how cells talk to each other and know their relative position and fate.

My interest in developmental biology originated during my undergraduate studies at the University of Delhi. I was keen to pursue an academic career in developmental biology using a vertebrate model system. My graduate training was in the US and then I moved back to India to pursue postdoctoral training. I was often asked, "Why do a postdoc in India?" Postdoc usually refers to an additional research training after PhD which is more often than not a stepping stone into academia and research. For most young researchers in India today, postdoc experience is typically attained in a lab outside India.

Postdoc culture is only just beginning to take shape in India with a number of postdoctoral fellowships slowly becoming available from the funding agencies. The number of postdocs has also increased over the past decade, although the majority of the PhDs undergo postdoctoral training in labs in

USA, Europe and Japan. Many research organizations also offer postdoctoral training programs to encourage potential postdocs to remain in India.

I am a product of one such program, the DBT-Young Investigator (YI) award at the Regional Centre for Biotechnology (RCB), Faridabad. The YI program encourages intellectual freedom to pursue scientific questions to build your independent research program.

A popular belief is that postdoctoral training in Indian lab cannot get you an academic position. The truth is, getting an academic position is challenging in either case. Publishing high-quality scientific articles from Indian labs is not impossible. Postdoc training in India does not always mean low productivity; what matters is the scientific questions you ask and how you choose to answer them.

I see many advantages to pursuing postdoctoral training in India. It helps you network extensively and set up collaborations amongst your peers and colleagues. In my case, a collaboration with CSIR-Institute of Genomics and Integrative Biology (CSIR-IGIB) was instrumental in pursuing the questions I was interested in seeking answers to during my postdoc training period. I could not have pursued that line of thought if I did not collaborate.

I do confess that it was physically exhausting to shuttle between two labs in two different regions of Delhi NCR, but it was all worth it. Collaborative projects also open up more job prospects in the same geographical region as well. One can move around and visit institutions and give job talks with more convenience. In my opinion, one learns to sustain oneself in the Indian academic environment faster and probably better as a postdoctoral fellow within the same system. On the flip side, one may not have as many "high impact factor" articles as compared to postdocs trained in leading labs in America and Europe.

Now, let's move on to applying for jobs. Is there a good time to apply? The answer is yes. The time to apply is when you feel ready. When you feel confident enough of the skills you have acquired so far in your PhD and postdoc and have begun nurturing ideas which will form the basis of your

future lab. When you feel ready to move on and take on a challenge of a very different nature – finding an academic position, joining the organization and setting up the lab.

The key is to apply everywhere. And I mean everywhere. There are a few fellowships available to transition into pursuing an independent research program such asDST-INSPIRE, The Wellcome Trust/DBT India Alliance fellowships and the Ramalingaswamy re-entry fellowship. The secret to success is finding a suitable host organization where you can begin your independent research program.

I began my independent research program at CSIR-Centre for Cellular and Molecular Biology (CCMB), Hyderabad, nearly a year ago. I was fortunate enough to begin experiments on day one itself. So, seek help from your peers and colleagues and use their lab to begin your experiments. Don't wait till you have set up everything in your own lab.

The lab will grow fast. The first few months are exciting as you have been dreaming of this for many, many years! It feels exciting and time seems short when you want to try it all. But a word of advice that I received from my senior colleagues and would like to pass on to you is – refrain from spreading yourself too thin and keep your focus on what you need to do to create a niche in your field.

Finding an academic position is initially a battle and being on the other side of the table as a PI does put immense pressure on you. Mentoring students, securing funding, writing papers, grants, paperwork and a ton of reading, together translate into a lot of work to do. The big change from postdoc to PI is less time spent on the bench but more on the desk. And yes, I do try to shuttle between the bench and desk. The balancing act is hard but I enjoy every moment of it – both sides are fun. Working at the bench keeps me alive and kicking. The desk gives me experience, it is where I get more time to read, write and reflect.

Mentoring students is another activity that is highly fulfilling, gratifying and critically important as they are the lab! Spending quality time with students

and helping them learn how to do science is important to create a healthy lab ethos. As you set up the lab, stick to your passion, interests and strengths. The pure joy of doing experiments to seek answers to your questions is hard to put in words. So enjoy every moment of it!

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Fail Faster, Fail Better

Mayuri Rege

Failure is an integral part of doing research. Whether it's the story of Edison's 1000 bulbs or Rosalind Franklin's trials leading up to the famous Photo 51 of the DNA double helix, failure is a lesson we should have learnt the moment we embarked on the research track.

However, ask yourself, how often do experiments fail in a typical undergraduate practical lab? For example, before the session on PCR, the teachers will often ensure that the band is always present and at the right size even though PCRs regularly fail in real-life research. To add to this, reference books and publications that students refer to typically discuss only the successful finding and breakthroughs without any mention of the multiple failed attempts it took to get there.

Thus, we do not adequately prepare young researchers to face the most frequent situation in a lab—a failed experiment! I reflect on my attempts to deal with this issue as I set up my lab primarily with undergraduate and postgraduate students in one of the top colleges in the country.

My first encounter with failure was when I was a master's student at the Tata Institute of Fundamental Research (TIFR), Mumbai. I wanted

to understand what made males more susceptible to malaria compared to females using a mouse model. We wanted to check for differential compounds in samples obtained in the least invasive method, namely urine.

Although it is pretty straightforward for humans, how does one collect mouse urine for analysis in a non-invasive manner? Since mice are not housetrained, we had to use expensive metabolic cages that had a special funnel design to collect the urine without disturbing the animals. However, I soon found out that our mice just would not pee in these cages! Bizarrely, they would just sit in one place, not drink any water and eventually die—even the control mice that weren't infected.

I changed multiple parameters—gave them different food, widened the pore of the water feeder so they could 'drink' more water but none of these made the mice 'happy', leading to several failed experiments and this becoming a running joke amongst fellow students. Eventually, I figured out that the bar spacing on the bottom of these cages was too wide for our mice to move freely- explaining why they were perched in one place. Placing a smaller spaced 'jaali' on the bottom immediately solved my problem and to my relief, I could finally collect mouse urine to perform my experiment.

Perhaps the first step of getting students accustomed to failure is to shift the focus from 'getting good results' to learning the research methodology. Teaching them to design experiments demonstrates the importance of controls that help to cross-check experimental conditions and give expected results.

But the first time our experiment fails to give an 'expected' result, my students are just dumbfounded – they haven't ever encountered this possibility before! Their knee-jerk reaction is to simply repeat the experiment as is because they presume that they have done something wrong along the way. On probing them about what might have gone wrong, they only have vague hand-wavy answers and no concrete reasoning that justifies repeating the experiment. This observation was a turning point for me as I realized that students need to be taught to step back and interpret failures.

Troubleshooting a failed experiment is what gets students to think critically because this time the answer is not already available on the internet. Importantly, I have to resist the urge to give them the answer and wait for them to arrive at the solution on their own. A natural consequence of this is that the students then proactively suggest what the next experiment should be – finally setting the scientific process in motion.

Another aspect of young researchers dealing with failure in the lab is at an emotional level. These are students who have excelled at academics and I have to remind them to not take failure in the lab personally. A failed experiment isn't a reflection of who you are as a person. Students who cultivate resilience in the face of failure and show the tenacity to work through it are the ones that actually succeed as future graduate students. Coping mechanisms might differ—my students will often burst out into hysterical bouts of laughter when their best laid (experimental) plans fail and then work together to figure out the next steps.

Designing experiments that can actively disprove your hypothesis is the only way to rigorously test your science. An experiment that discriminates between your favourite hypothesis and others and can disprove your hypothesis is more important than several peripheral experiments that support it. There are two facets to this – avoiding confirmation bias and saving time.

An important skill to acquire as a young researcher is to identify that smoking gun for a given hypothesis – something that can happen if and only if the hypothesis is true. In practice, this is hard to achieve and such a smoking gun often involves a combination of observations. However, these are the experiments that must be done first in order to test the hypothesis effectively and fail quickly if we have to. This saves time that would have otherwise been wasted on inessential experiments.

How can we remove the fear of failure at the undergraduate level? One possibility is by changing the metric of performance for research done in colleges. We can reward original thought and proper research methodology, whether or not it leads to publishable results. While this is harder to assess, we can recognize undergraduate teachers who emphasize 'how to do research'

rather than getting their students to produce results that lead to publications in predatory journals.

In our Department, we have implemented this through rigorous discussions of projects proposed by teachers by their peers. We also grade our students for clarity in formulating a hypothesis and engagement in discussions on experiments rather than just showing a result. Although it's too early to tell if this works for a majority of institutions, we see a remarkable improvement in students' ability to tackle problems after being subjected to frequent failures.

By letting them fail early, undergraduate research can teach students the correct process of doing research, prepare them for graduate school in the future and meaningfully contribute to the research enterprise in India.

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Twist, Turns and Interesting Observations

Drove me to Chase Diverse Areas

Sangeeta Nath

One has to travel through a series of experiences—ups and downs—to reach a career path where one can pursue his/her passion or interest. I am not an exception—my path was neither smooth nor linear. Looking back, I can clearly see that every time I felt stuck, I found a way to take a turn and continue pursuing my interest.

At school, I was not very clear about which way my life would take me. I was still not ready to explore places that were not near my house, so I joined an undergraduate course in pharmacy at Jadavpur University, Kolkata. This was the beginning of my journey in the field of bioscience. The pharmacy course exposed me to the excitement of molecular biology and biochemistry. So I decided to pursue MTech in Biotechnology after finishing BPharm at the same University. During my MTech, guest lectures by Debasish Bhattacharya of Indian Institute of Chemical Biology (IICB) influenced me deeply and I joined his lab to do my PhD.

My PhD work focused on how proteins form aggregates. I continued my postdoc in a related field at KU Leuven, Belgium, in Yves Engelborgh's lab. The work was exciting and successful in terms of publications but I wanted

more. I wanted to understand how protein aggregates in the brain gradually lead to the development of diseases like Alzheimer's and Parkinson's.

While working in Leuven I got an offer from the geriatrician Jan Marcusson and pathologist Martin Hallbeck in Linkoping University Hospital, Sweden. I decided to work with them, despite knowing the risk of taking a diversion from a biophysics research lab to work under a team of physicians. The very first day, they explained how protein aggregates start forming in one part of the brain and progress gradually through the connected areas. It was a fascinating discussion and gradually our complementary thoughts and expertise evolved into our most cherishable work.

For the first time, we showed the direct transfer of protein aggregates from one cell-to-another and how they gradually cause toxicity within neurons. Interdisciplinary ideas helped me develop an independent research pathway and I served as the corresponding author on two research papers published during this time. I was also elevated to a permanent research-staff position by Linkoping University due to my accomplishments.

I got intrigued by observing under the microscope the transfer of protein aggregates from one cell-to-another via thin neurite-like connections. During this time (2009 onwards), a couple of research groups also started to report cell-to-cell transfer of neurodegenerative proteins via thin continuous membrane connections or membrane nanotubes, which they termed as 'tunnelling nanotubes'. My hunch was that the formation of these tunnelling nanotubes is linked to the toxicity of lysosomes, a cellular organelle. My inquisitiveness about lysosomes led me to work with Karin Ollinger and Katarina Kagedal at Linkoping University, two lysosome experts.

At this point, I got obsessed with the science of understanding how cells communicate with each other. However, I always set my family and daughter as my first priority. When you see a little baby growing gradually in front of your eyes, then life is not only about career or science. We, as a family, were contemplating coming back to India. Subsequently, we moved our base to Bangalore, the software capital of India, and like a dutiful wife and mother, I started from scratch in a new city.

I was getting job offers in Bangalore, but not the one I wanted. Then, coincidentally, I got an offer from Institute of Stem Cell and Regenerative Medicine (inStem), Bengaluru, for developing methods of imaging by visualizing movements of a single protein on the cell membrane, in collaboration with Satyajit Mayor of the National Center for Biological Sciences (NCBS) and Akihiro Kusumi of Kyoto University, Japan — a pioneer in the field of single-molecule microscopy. Immediately my mind jumped to membrane structure and I realized the tremendous potential that super-resolution imaging might have in understanding the relatively unexplored area of membrane nanotubes.

While single-molecule microscopy seems like a different field from protein aggregates and neurodegenerative diseases, I got many of my answers on tunnelling nanotubes from Satyajit Mayor's classic works on membrane and endocytosis. The work gradually started engulfing my thoughts.

All of a sudden, one fine day, I read a review article by Chiara Zurzolo, a pioneer in the field of 'tunnelling-nanotubes'. In the review, two of my publications got pivotal attention with overviews on the spread of pathology by lysosome and tunnelling nanotubes. I had been thinking obsessively over the years about the link between lysosomes and tunnelling nanotubes. The article moved me to take the decision to re-start my work on tunnelling nanotubes.

I started applying in academic institutes in Bangalore and reached out to Gopal Pande who heads the Manipal Institute of Regenerative Medicine (MIRM) only a couple of kilometres away from NCBS. MIRM is a constituent institute of Manipal Academy of Higher Education (MAHE) which is a National Institution of Eminence (IOE). My seminar in MIRM was well received. The enthusiastic response of the faculty and students impressed me and I decided to apply for a faculty position there. To get an Assistant Professorship, my CV had to be approved by the core research committee of Manipal. I can never forget the support I got from my collaborators and mentors who sent me wonderful recommendations to support my application. Finally, I got an offer to join with a seed fund to establish my independent

research lab.

I can't deny that I have received unflinching support from my colleagues in MIRM and MAHE of Manipal. My cell culture lab got set up within 4 months of joining the institute. Whatever I asked from my colleagues and the Dean to begin my lab, I received almost immediately. I already have some preliminary results from my new lab. Additionally, I am enjoying teaching and mentoring some enthusiastic and bright MSc students who always keep me on my toes.

Now that I have got the platform I needed to pursue my research, I am fully charged to begin experiments for understanding how cells communicate with each other via tunnelling nanotubes. However, this is also the beginning of new challenges. The field is relatively underexplored by Indian scientists, even though it is an internationally flourishing area of research. I know the research path I want to follow, but overcoming difficulties and challenges beyond science is still a learning curve for me.

Many more challenges lie ahead – e.g. getting funding to set up appropriate infrastructure for a beginner in the field, establishing my observations as relevant to disease mechanisms and basic cell biology principles etc. However, I earnestly believe that my diverse expertise will have an enormous impact in revealing a relatively underexplored area and I will not lose my passion in moving forward and finding new ways to overcome difficulties in this journey.

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Part 2

Getting Started

The Circle of Trust and Mentoring in a YI's Journey

Sudhir Ranganath

The lack of research culture and the thrust given towards innovation in private engineering institutes in India is a matter of concern, though it is changing slowly. Under such conditions, a YI has to rely on trust-building and networking skills along with technical skills to get going. Here is my brief story.

A tough decision

I had already made a tough decision towards the end of my postdoctoral stint at Harvard—of coming back to India and working at my bachelor's degree alma mater (Siddaganga Institute of Technology (SIT), Tumkur), purely for personal reasons. My plan was to do minimal teaching and establish a research lab focused on developing biomedical devices, including biosensors, drug delivery devices, and therapeutics. I then started wondering how would I achieve this feat in a privately-funded academic institute with no infrastructure for performing biomedical research. While this was a formidable challenge, I relied on my prior research experience and the mentoring/networking support I had.

The first task was to convince my institute's management that I would stay

put and contribute to the institute's research output, given my track record and the possibility of offers from IITs or NITs. I was offered the position with an extra year of probation (3 years instead of 2) probably with a slight sense of caution that I might not stay too long. After joining the institute in 2015 and after a few months of adaptation, I developed a roadmap of my research activities but soon realized that the infrastructure was totally absent. Nevertheless, I was resolute in letting the management know that I needed a good amount of seed funding, given the capital-intensive nature of biomedical research.

A chance encounter

Six months into my job, the director of my institute invited me to attend an informal interaction with a renowned professor from the US. This chance meeting changed everything! The professor introduced himself as a chemical engineer working on ocular drug delivery, ocular pharmacology and fluorescence spectroscopy and I was so excited to hear that our interests matched. He was also impressed with my track record and motivation to do cutting-edge research and after a few Skype discussions, he saw in me a potential collaborator.

I persisted in discussions with him for about 3 to 4 months, and we then jointly wrote a proposal for establishing a research lab at my institute focused on ocular drug delivery and diagnostics. Things moved slowly when it came to getting approvals from the management. However, after about a year, we could convince the management to provide me with about Rs 50 lacs as seed money. Here, I would like to highlight and complement my institute's vision and belief system in its faculty members, without which I would never have been the first faculty in its 65-year-long history to get such large seed funding, that too so early in service. Simply put, they trusted me to deliver.

Getting the research infrastructure ready

Getting a hefty seed funding was only the beginning and the challenge of setting up a research lab was daunting. Fortunately, space was not an issue and I earmarked about 30 ft x 40 ft of lab space. I also noticed that our

department lacked a dedicated central analytical instrument facility and a seminar hall. Even though I was the junior-most faculty in the department, I did not hesitate to put forward my views to the authorities of getting these infrastructure developed and we got them approved. A big area was earmarked for my lab, instrument facility, and a seminar hall, and was constructed in about 8 months.

I had to work from scratch, starting from lab design to furniture to layouts. It was particularly hard because chemical synthesis, cell/molecular biology studies, microscopy/fluorescence spectroscopy work, cell culture and modelling/simulation work needed dedicated and separate spaces and I had to chalk out a plan to accommodate them separately without wasting space. Here, my previous lab experiences and a great deal of guidance from my postdoctoral advisor (who is a biologist) helped. By the end of 2016, the lab was ready to be occupied.

Strategizing my first moves in a new research lab

- *Setting up a vision for the lab*

One of the most critical aspects of starting a new research lab is to identify target areas of research. The golden rule is to never choose exactly what you did in your postdoc or PhD because your advisors will be your primary competitors. However, this rule has exceptions. You can always borrow skills from your PhD and postdoc experiences. I knew clearly that I would harness my expertise in drug delivery, biomaterials, nanotechnology and chemical engineering for biomedical applications including ocular pharmacology/drug delivery/biosensing, given the tremendous support and expert advice at my disposal from my US collaborator. With this clear vision, I named my lab as Bio-INvENT Lab which stands for Biomedical Innovations via Engineering & NanoTechnology lab, which is appreciated by many for the ingenious use of words.

- *Getting the first set of equipment and manpower onboard*

With the seed funding, a few critical sets of equipment were procured

and were set-up in a temporary lab space (since the new lab was still under construction). A critical challenge still remained—getting quality students to work on my ideas because most of them prefer to join premier public-funded institutes such as IITs or IISERs. In private institutes like SIT, students rarely join a lab unless they see the potential for a productive PhD and a reasonably good advisor.

With this limitation, the only option I had initially was to work with undergraduate students. I and my US collaborator spent hours interviewing them for projects and finally, my first batch of 12 undergrads was onboard. Even though they could contribute little initially, experiments were initiated. Again, by chance, I was approached by an SIT alumnus for PhD guidance. She had prior knowledge and interest in drug delivery and was keen to work on cell culture, and I readily accepted her as my first PhD student. Together, we then slowly recruited more undergraduate students and in early 2017, we moved to the new lab.

Running and sustaining a new research lab

The lab was now fully functional with a PhD student and several undergrads. I made a point to talk to undergrads about my projects and what they would gain from working with me, which led to motivated undergrads joining the lab and we slowly made progress.

As projects and working hands grew, I needed a sustained rate of funding to run the lab. Though I had procured some critical equipment, we needed many more to become self-sufficient. My institute allocates annual research funds for each department and I make a point to get it every year. Later, after a brief interaction with a few scientists from Bhabha Atomic Research Centre (BARC) who had visited SIT, I wrote a proposal and submitted to Board of Research in Nuclear Sciences (BRNS) which got approved after a year (mid-2018). This was my first competitive extramural grant of about Rs 30 lacs (for three years). My interactions with my US collaborator continued and based on our ideas, I wrote another grant proposal to the Science & Engineering Research Board (SERB) which was approved towards the end of 2018. Just after a year of establishing the lab, I had about Rs 65 lacs as

extramural funds.

I also ensured that weekly lab meetings were held and students presented their findings cogently which helps them develop scientific communication skills. With a very productive bunch of graduate and undergrad students, I decided to apply for a few innovation/entrepreneurial grants such as the India Innovation Growth Program University Challenge 2019. We worked really hard on the proposal and the presentations and got a grant of Rs 10 lacs among more than 2500 applications nationwide in the middle of 2019.

In addition, every year my lab's undergrad students have been securing Karnataka State Council for Science & Technology (KSCST) grants for projects from the Government of Karnataka consecutively for the last four years. Multiple awards to my students at conferences at IITs, NITs etc. have been a norm in the lab, thanks to these highly self-motivated kids. We also started publishing high impact research articles/review papers and book chapters regularly. These smaller successes have also motivated me to keep learning new skills and keep abreast of the latest happenings in the field.

In summary, a steady flow of ideas, funding and active manpower has now been established after three years of hard work!

In addition to these, sustained networking with researchers and industries worldwide and forging collaborations with them have led to multiple ideas and projects. The cross-disciplinary nature of research in my lab necessitates my collaborating with doctors, pharmaceutical scientists, material scientists and basic biologists/chemists. Another advantage of networking is that you get to write invited reviews/book chapters and also to serve as editors and reviewers, thus expanding your professional reach and credibility. The Young Investigator Meeting (YIM) is one such fantastic platform for networking and I advise all would-be YIs to attend YIMs.

Lastly, my vision for the lab was to not only develop ideas and test them, but also to bring them into the market. Hence, we have now started pitching business proposals based on the ideas developed in the lab in national entrepreneurial competitions. Also, I have recently begun a start-up venture

along with a few of my engineering buddies focused on developing process chemistry for pharma industries. During the initiation of this venture, I and my partners learnt and assimilated entrepreneurship skills. I see this as an exercise to facilitate bringing my ideas into the market and create social impact in the field of healthcare. We have also hired my own students in the start-up.

In summary, the mentoring and trust that I received from my higher-ups during my student/postdoc days has come a full circle, in the sense that I am now in a position to trust and mentor my students towards success. I hope this continues.

This article is dedicated to all the Bio-INvENTees, collaborators and faculty colleagues for their everlasting support and to the gracious management of SIT and funding agencies, who have funded for the establishment of the lab and its ongoing research activities. Being in my hometown and only 5 mins away from the lab, I enjoy the fullest support from my family too, be it late nights or weekends!

I still have a lot to achieve as a researcher and innovator, but if this story of mine helps someone get critical cues and points to ponder upon in their journey as a YI, I will be satisfied writing it. So, all the best to the current and future YIs.

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How to Get Going as a Young Investigator

Vivek Borse

Once the initial phase of selection and joining is over for a Young Investigator (YI), the major challenge they face is how to actually get going at the work place. By this, I mean finding 'lab space' where one can set up their work bench, instruments, equipment, and writing desk.

Most YIs don't know beforehand how much space they will be provided with after joining an institute. In most institutions, there is difficulty in allotting space to YIs as most of it is already occupied for other departmental purposes. This is also a time when the YI's mind may be preoccupied with the dilemma, anxiety, uncertainty and excitement of accepting an offer to start their scientific career.

Different host institutions have different norms for facilitating this transition for the YIs. For YIs who receive limited-term fellowships like DST-INSPIRE, Ramalingaswamy Fellowships, and Ramanujan Fellowship, the situation can be murkier. Many institutions try to pair such YIs with a 'Mentor' in the institution, so that it will be a little easier for YI to start working. Other institutions recognise these YIs as 'Independent researchers' and consider it the YI's sole responsibility to get support, find space etc. Both situations,

whether working with a mentor or working independently, have pros and cons, as mentioned below.

I am a DST-INSPIRE Faculty Fellow and I opted to work independently, so most of the discussion here is from that perspective.

Working with a Mentor	Working Independently
Pros	*Pros*
Easier to get a head start - access to space, equipment and instruments	Do-it-yourself experience, opportunities to learn how to establish a lab from scratch
Easy access to departmental/central common facilities	Freedom to think and work independently
Intellectual support and help in quickly getting started with experimental work	Individual right to the intellectual property generated
Access to students or staff for helping with experimental work	Chance to grow an extensive network through collaborations
Administrative support for quick and easy approvals	Chance to experience direct responsibility in the administration
Cons	*Cons*
Reduced freedom to work and think	Struggle for space and facilities
Limitations on spending research grants	Limited administrative support
Additional steps for processing any administrative document	Risk of stumbling if funds are limited or discontinued
Shared intellectual properties and publications	Increased physical and mental stress for having to do everything on one's own
Risk of losing opportunity to develop independent career objectives	Losing momentum of thinking due to situational roadblocks

One important factor to consider is the delay (can be up to 4 months) in fund sanctioning and release after joining a host institution. During this period, there may not be any salary or research grant support, which may make it really difficult to start working. The best options during this period are

to carry out literature review, write research grant proposals, finish pending manuscripts, attend local conferences, and collaborate with faculties in the institution or places around. For these activities, the only requirement is a computer system/laptop, internet connectivity and a desk, which is usually provided by the host institution upon joining.

Collaborating with faculties in the host institution can also solve many of these issues. It is easy to find faculties working in similar research areas and locate common facilities that the YI may find useful. The host institution may also provide some temporary space to the YI based on availability, for which patience and consistent follow-up is required. YIs can also locate unused space in the institute and approach the appropriate authority with a proposal to use that place for starting their lab, even if it is as a temporary arrangement.

Here are some tips to follow before joining any host institution:

- Check the rules and regulations, as well as the recognition norms offered by the host institution, with regards to availability of individual working space, allotment of students/staffs, teaching responsibility, involvement in routine departmental administrative work, availability of accommodation on campus, etc. before joining. Many research institutes provide detailed information on their intranet, which is usually not accessible from external networks. Hence it might be advisable to ask the appropriate authority about obtaining the written norms.

- Check the probability of getting a regular/permanent position in the host institution, especially if you are on a temporary fellowship like the DSTINSPIRE grant. YIs must look at this factor very carefully as the pressure of getting regular position builds up with time. Research areas, faculty requirement procedures, department/centre strength, courses offered, etc. are some of the factors to be considered while deciding whether or not to apply for a permanent position.

- Decide whether you want to work with a mentor or independently,

perhaps once the host institute is finalised. One more point to note here is, it is really challenging to move on from 'with mentor' to 'independent' researcher, but vice versa is possible. Once a YI starts working with a mentor, the work environment, culture and association may begin resembling the relationship that exists between a PhD scholar and guide. As a result, once the YI moves on to working independently, there may be unavoidable, unexpected, unfortunate conflicts or disputes over various matters. So, it is better to be clear upfront about the level of independence and professional relationship.

- Accommodation is also an important factor that should be considered while choosing the host institution. Check whether the YI will be provided with accommodation on campus.

Here is some advice on how to get going once you join the host institution.

- Upload/send any required documents at the earliest after joining and follow-up with funding agencies on a regular basis to expedite the fund sanction and transfer process.

- Get acquainted to the formalities and procedures (intranet email domain, software interfaces for purchase, administrative applications etc.) in the institution. Enquire about the procedure of internal applications for the purchase of material, travel, staff recruitment in your project etc. Be nice with the administrative staff; this really helps speed up the procedures for you.

- Look for unused space and blind spots that can be converted into temporary work space. Don't hesitate to consult the concerned authorities, but don't do anything without getting the necessary approvals.

- Look for the collaboration opportunities in the institution or within the city or region. You may be able to start working in your collaborator's work spaces until you get our own.

- Keep interacting with the other faculty in the institution and never get

isolated. Learn about the work going on in the institution by attending conferences, talks, seminars, workshops, etc. Let everyone know about your work or progress, which may lead to a chance of collaboration or a new activity.

- Most importantly, get helping hands. Look for graduate students from your collaborators' lab or recruit staff on your own project as soon as possible. Having others work on your project saves lot of time and doubles your productivity.

- Spend wisely on material, equipment, accessories, etc. Consult with other YIs about the process. Maintain your own stock-entry register and purchase records. Keep track of financial year ending etc. and accordingly plan your purchases and prepare your documents.

Getting an opportunity to start a career as an independent academic researcher needs significant work and effort. Apart from scientific ideology and intellectual performance, there are lot of considerations in the beginning for a young researcher. YIs must think carefully about the points discussed in this article, as this may help them focus more clearly on the journey that they are embarking upon.

He is one of the researchers selected to attend YIM2020 as a Young Investigator(YI). In this invited article, he writes about some strategies to speed up the process of getting started after joining an Institute as new faculty.

Vivek Borse is a DST-INSPIRE faculty fellow at the Centre for Nanotechnology, Indian Institute of Technology Guwahati.

To be or not to be at the Bench

Amit Lahiri

It is surprising that we spend decades working at the bench aspiring for a time when we don't have to do it anymore. On average, a young faculty must have spent around 8–12 years doing their doctoral (PhD) and Postdoctoral research training. During these years, the major goal was to be productive at the workbench and effectively translate the lab results into publications in peer-reviewed journals.

As a young graduate student or postdoc, one is expected to do their quintessential reading and writing in their spare time ("beyond the core working hours when you are not busy doing experiments"). After all those years spent working at the bench, a young PI, upon securing a position and finally gaining a laboratory of his/her own with grad students and project trainees, can now finally read, write, and execute his research goals at peace in his/her little cubicle (called his/her office).

On a personal note, I keep wondering to what extent a new PI should/can contribute to working at the bench after landing the coveted assistant professorship. How can one juggle time between writing grants to procure funds essential for running the new laboratory, the mandatory teaching

assignments, and, of course, the administrative responsibility?

I feel the answer largely depends on your PhD students, the start-up funding that you have received, and your passion for bench work. In academia, a Principal Investigator (PI) is definitely expected to have teaching responsibilities to a certain extent (courses and extensiveness varying between Institutes) and that decides one's schedule.

Let us discuss this with some examples.

- *Early students and start-up funding:*

It has been said by many that the early/initial students build your career. If there is someone with you who is not a novice to handling a pipette, has a good technical grasp (perhaps owing to any short-term research training they might have undergone during their undergrad years), and has a good scientific acumen, it is certainly an advantage. For example, if you could afford to hire a postdoc early in your career, it's definitely a boon as you can spend more time writing grants, while you can trust the postdoc to oversee/teach your first-year graduate students.

On the other hand, if the institute provides a healthy start-up grant, you can start slow on writing grants, without worrying too much about the resources to run the laboratory. In such a case, you can directly start working on the projects which might help you to get your first paper out soon.

- *Teaching and administrative work*

Research institutes differ in their course curriculum and thus the teaching responsibilities vary widely across institutes world over. Certainly, this factor decides how much time you can dedicate as a new PI to carry out experiments in the laboratory. You are also expected to handle multiple administrative responsibilities, which in turn dictate your spare time. Getting human and animal approvals for the experiments you intend to do, visiting hospitals to establish effective collaborations to procure patient samples, etc. also take up a lot of time and play a role in determining how one can segregate their free time between bench work and writing.

- *Love for bench-work and trust issues*

Now some of us really love doing our own experiments. There are many of us who do not want to forego the joy of doing experiments, generating results, and see their research hypothesis working. These PIs can serve as an experienced extra working hand, especially early in their career. There is a high probability of mistakes (calculation errors etc.) while working with inexperienced students which would drastically change the course of expected results. This is when the PI has to dedicate time to guiding and patiently teaching his leading warriors – the first few students! These factors can also modulate your working habit in the laboratory as you need to put in extra hours doing experiments in such cases.

- *Generating preliminary data and standardizing everything*

One of the major hurdles an early career investigator faces is to generate preliminary data for grant applications. To generate the preliminary data, a young PI needs to work in the laboratory as you cannot really expect first-year students to get publication-quality data in a new lab. One needs to standardize everything and that too with very limited resources. Letting the novice student do those early and deciding experiments completely on their own is a great risk for a new PI, as in the end, one might just end up losing precious reagents without anything getting accomplished. Further, it will be easier for an experienced person like a young PI to perform the first set of experiments and standardize the experimental procedures so that students can reproduce the data.

- *Balancing work, writing, and training students*

Once the preliminary data is generated and the first grant is secured, it becomes very crucial to balance work and writing. One needs to carefully plan all the endeavours. One should start training the students by carefully planning the experiments. Next job is to make sure the students are able to understand what is expected from them and they are getting better both at the bench and reading. In the meantime, a new PI needs to start thinking about the next grant submission and hopefully, by then the students are adept

at generating the next set of data that could be used as preliminary data. Given that a PhD is a training program, one cannot expect too much from a first-year student. It is the responsibility of the PI to train them appropriately and then base their expectations on the quality of such training.

- *Life is not easy, but it's your data*

Let me share my experience with you here. I joined CSIR-Central Drug Research Institute, Lucknow as a Senior Scientist just about a year ago. I initially took two summer trainees. They were instrumental in setting up the laboratory and procuring reagents to perform the early experiments. The first few months, I worked with them religiously and generated some basic data, though of rather poor quality. After almost 9 months of slow but steady work, we started getting some results.

When two PhD students came on board, things started to look a little better. To get the preliminary data for our first grant, I worked constantly in the laboratory with the students and the trainees. Each step of every experiment was performed together, we discussed all problems that arose, and performed troubleshooting on a daily basis. Finally, I could submit our first funding proposal.

Now with the first grant being sanctioned, I am momentarily free of my funding woes. I have started spending more time on writing other funding applications and with three PhD students, it appears that they might quickly become accustomed to independently doing experiments. We talk every day, discuss what they plan to do, and if all the resources to perform the task are available. We discuss the results once weekly. I am hopeful that in a year or so, the students might become adept at working and thinking independently and be able to take the project forward on their own without my constant presence in the lab.

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Establishing and Maintaining Collaborations Internationally

Jagadis Gupta Kapuganti

Doctoral studies at the University of Wuerzburg, Germany introduced me to plant nitric oxide signalling, where I discovered that mitochondria participate in synthesising this fascinating molecule and play a crucial role in plant-pathogen interactions. I had a great mentor - Werner Kaiser - and I really enjoyed working with him during my PhD. At the end of my PhD, he permitted me to write a complete research article by myself, from drafting till communicating. As a result, I ended up getting my first corresponding author paper from my PhD work which boosted my confidence about working independently.

During my work at Max Planck Institute of Molecular Plant Physiology, Golm, Germany I investigated the molecular basis of regulation of respiration in plants. This provided a basis for international collaboration as I met people in the nitric oxide community and started developing contacts and writing joint articles. Later I joined the University of Rostock to work on photorespiration.

After that, I got the Marie Curie Intra-Europe Fellowship at the University of Oxford. My mentor George Ratcliffe and Oxford taught me how to

establish strong collaborations. I also learnt time management, leadership skills, and effective productivity at Oxford learning Institute. I was also the coordinator of the life sciences division of Oxford Research Staff Society.

After the successful completion of the Marie Curie Fellowship with an excellent publication record, I thought of starting my independent career in India. I attended YIM 2014 in Hyderabad as a postdoctoral fellow and met several directors of institutes. I decided to apply for faculty positions in the same year. I received several offers and chose to join the National Institute of Plant Genome Research (NIPGR), New Delhi (in 2014) as Scientist IV.

As soon as I moved to India, I had a choice between two prestigious fellowships, Ramalingaswami Fellowship and Ramanjunan Fellowship, both of which I had qualified for. I chose the Ramalingaswami Fellowship and was later awarded the Innovative Young Biotechnologist Award (IYBA) award by the Department of Biotechnology (DBT), Government of India.

At this point, I started thinking of applying for grants and saw the advertisement for UKIERI jointly funded by British council and DST. I applied with Luis Mur from Aberystwyth University, UK, who I had collaborated with previously, and got the funding to work on nitrogen use efficiency in plants. This project turned out to be very successful. Later I applied for the Department of Science and Technology and German Academic Exchange Service (DST-DAAD). This application was also successful and provided the opportunity to collaborate with Alisdair Fernie, Group leader of Max Planck Institute of Molecular Plant Physiology whom I admire and am inspired by.

It is great to collaborate with people who are both brilliant and energetic and always guide and stimulate fruitful discussions leading to high impact publications. I also got an Indo-Portugal project to look at alternative oxidase (AOX) role in seeds.

I thought of expanding my research into a translational level. I contacted Theresa Fitzpatrick, University of Geneva, Switzerland and successfully applied for a competitive Indo-Swiss Grant on Blue Sky Research on Enhancing vitamin B6 in chickpea and rice. Excellent ideas and hard work

paved the way to get these competitive international grant research grants.

Currently, our lab is collaborating with Germany, UK, Portugal, Canada, Russia, and France. I am an active part of the International nitric oxide club, a group of scientists working on plant nitric oxide. Active involvement in such groups positively drives collaborations.

Since national collaborations are also important, I started collaborating with my colleagues at NIPGR. It is crucial to not only establish but also maintain collaborations to keep them strong in the long run. Along these lines, I was actively involved in organizing an India-EMBO symposium on 'Sensing Signalling in Plant Stress response' this year together with Ashwani Pareek (Jawaharlal Nehru University), Sneh Pareek (International Centre for Genetic Engineering and Biotechnology), and Christine Foyer (University of Birmingham, UK) where we invited international experts, editors of top plant science journals, and potential collaborators, both national and international. Organizing international conferences like this often attracts further collaborations.

Another crucial part of bringing in new collaborations and expanding one's network is writing papers with several experts worldwide with phenomenal support. This can also help your work get recognised. Organizing special issues and books to bring experts and collaborators under an umbrella is another way to develop collaborations. After I started my career in India, I edited three books on plant respiration methods, nitric oxide methods, and nitrogen metabolism in plants. I recently received an invitation to join as an Editor in Planta, an international journal for plant science research.

For successful collaborations, it is important to focus on a few aspects and become an expert in the area, because too much diversification may lead to reduced focus This would give you in-depth knowledge to elucidate novel phenomena and generate innovative ideas. I tried to focus on nitric oxide signalling and hypoxia tolerance.

Once you are established, it is important to start translational work as well, to maintain a balance between basic and applied work. It is also great

to know that basic research can help in developing products with a good commercialisation strategy.

My suggestions:

- *Attend international conferences focused in your area:* One of the best strategies is to attend international conferences where you interact with peers with similar interests and try to discuss your work and arrive at some ideas for establishing collaborations.

- *Don't lose touch with collaborators:* It is crucial to have continuous interaction with collaborators, Interact and share experimental data with each other and start writing papers together.

- *Leverage your existing collaborative relationships*: Collaborations become successful when you work with people you already know and with whom you might have invested a significant amount of time and effort in building trust. One should note that you always need new ways of thinking, such as bringing different expertises together. The best strategy is to start with a previous collaboration and then expand the collaborations with new people.

- *Apply for international projects:* One of the cornerstones for success to secure funding along with collaborations. DST and DBT have several international projects; hence apply for these grants with collaborators abroad.

- *Start journal special issues and books:* Another way to develop collaborations is to try to organize special issues and books, thereby expanding your international network.

- *Organize international conferences:* Organizing international conferences can be somewhat tedious, but it can provide one huge benefit and international visibility.

- *Work hard and keep the collaboration going*: You need to establish a successful base. If you are the lead coordinator, you need to establish

norms, understand the strengths and weaknesses of collaborators, and constantly work to keep the collaboration intact and live.

Developing and maintaining collaborations requires constant effort. It also takes time. The best strategy is to plan it out at the beginning when you are establishing your lab, and then start working on it to make it successful.

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Part 3

Exploring New Niches

Joining a Private Research Institute

Challenges and Strategies

Amit Agarwal

When I started thinking about my career aspirations after completing my bachelors in Pharmacy, I was sure about getting into research. However, I would have never imagined running my own laboratory. As with most pharmacy students in India who are interested in research, I aspired to someday head the R&D department of a pharmaceutical company.

I completed my MS in Pharmaceutical Sciences from the University of Southern California, Los Angeles, and continued in the same laboratory to complete my PhD in Molecular Pharmacology and Toxicology. It was while doing my doctoral research that I came to appreciate the importance of scientific freedom and the ability to choose my own area of research.

At the end of my doctoral studies, I was hoping to catch a break from hard-core research, as I was exhausted from the daily grind of thinking of experiments day and night. As I was initially hoping to get into a pharmaceutical company, I had tried to develop some corporate pharma skills by taking courses in Regulatory Science during my PhD. This helped me easily find a job in a commercial ethics committee to help small clinicians and non-institutional researchers get their research proposals reviewed for

following ethical guidelines while conducting human clinical research.

A year and a half in this position made me re-discover my love for research. My mind was itching for stimulating discussions and more complex problem-solving. I was looking forward to getting back into research with renewed vigour and excitement.

At this point, I got an opportunity to join Chest Research Foundation (CRF), Pune, who were looking for a basic research scientist to drive molecular research which would add onto their already accomplished clinical and public health research profile. This was a perfect fit for me given my basic research background in cigarette smoke-induced pulmonary impairment. I could test out my hypotheses in human clinical studies at CRF. 100% time dedicated towards research, scientific freedom to pursue research ideas and an opportunity to transform a primitive molecular research program [NJ1] into a pioneering one, were some of the most important considerations that led me to choose this opportunity. The institute being in my hometown, Pune, was the cherry on top of the cake.

When I tried to read and gather more information online on what I could expect while establishing my own research laboratory in India, I learned about some of the challenges associated with funding, resources, and bureaucracy, but none from a private research-dedicated institute perspective. I assumed most of these challenges would also apply to my position at CRF – which was true. But there were also other challenges, which I never thought about. Some of these were:

- *Delays in procurement of consumables:* Planning research experiments is a dynamic process, which requires constant adaptation and change of plans. It may not always be possible to foresee the requirement of a chemical or a consumable. The vendors take anywhere between 4–12 weeks to deliver a product, once the order is released, as most of the consumables are procured from abroad. Adding to that at least a week to navigate your institutional process to get the order released, a sudden requirement of a consumable may set an experiment back by 2–3 months.

The only part in your control is minimising the institutional time required to place an order and following up with the vendor to ensure that they follow their promised timelines. Although this also applies to public-funded institutes, the problem there is mitigated by the fact that there are usually 2–3 groups working in similar research areas from whom you could borrow some consumables until your orders are fulfilled. Researchers from other institutes are mostly helpful in these cases, but it requires networking and effort to develop such relations.

- *Shared resources:* Most of the research institutes in India and abroad with more than one basic science research laboratory have a shared resources facility so that each lab would not have to invest in capital equipment or instruments individually, along with their maintenance. These resources are usually shared, which not only helps in reducing costs but also allows for better utilization of the resources. As a single lab in a private research institute, these costs have to be borne alone which significantly adds to the budget. This could sometimes limit the number of available methodologies to interrogate a research problem.

- *Setting up collaborations:* Another challenge for a researcher in a private institute is setting up collaborations with other research laboratories. Networking becomes all the more important for a researcher in a private institute given the smaller number of connections you can make through the institute or its researchers. Institutional policies may also direct which parties you can collaborate with and not.

- *Funding challenges:* Applying for and generating funds is another serious challenge as some grant opportunities may only be open for government/public research institutes. I have had at least one grant proposal rejected for the fact that my institute did not have other basic science researchers who could help me in case I reach a dead end. Thus, collaborations almost always have to be multi-institute which may add to logistical costs.

- *Recruiting student researchers:* Being in a university campus or a national research institute may make it easy to attract student researchers who can pursue masters and PhD degrees while working in your laboratory.

Private research institutes require affiliation to universities to be eligible to recruit students. The research staff at the institute also need to conform to the university's eligibility criteria to be PhD guides.

I would like to advise other young researchers planning to move to India and/or starting a laboratory in a private research institute to network as much as possible. This is a one-stop solution to most of the above challenges. For YIs planning to move to India from abroad, it would help to inquire within your network abroad if they know any investigators in India who may be your potential collaborators. Attend local scientific meetings to meet senior investigators and get them excited about your research.

I would also suggest to the young researchers that they carry the best practices from wherever you move, be it from abroad or within India. From my personal experience, I realized that students in India do not take deadlines for presentations or reports seriously enough. However, students abroad usually have a midnight deadline for assignments and the first thing they get to learn is the strictness of this deadline. Building such systems could be daunting initially, but will contribute to the research culture in India and provide you with the satisfaction of helping transform the careers of those next in line.

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Advantages and Challenges of Doing Science in a Hospital in India

G Velmurugan

I am a biologist hailing from a completely research-based academic background. My Bachelor's degree in botany from the prestigious St Joseph's College, Tiruchirappalli laid the foundation and created an interest in environmental studies and microbial ecology. However, at that juncture, a real passion for science and research had not yet blossomed in my heart.

My subsequent entry into the renowned and inspiring campus of the School of Biological Sciences, Madurai Kamaraj University, for my post-graduation created a deep-rooted dedication and passion for research. I am very confident and proud in reiterating that this transition towards a research mindset happened within a short time span of two to four weeks, through inspiration gained from observing the dedicated lifestyle of PhD scholars and motivation from my professors. Till date, I always cherish those initial days and share my recollections with my family, friends, and students.

Subsequently, for the past one and a half decades, I breathed in the research atmosphere at Madurai Kamaraj University, University of Cologne (Germany), Indian Institute of Technology (IIT) Madras, and University of Florida (USA). In all these places, I was surrounded by PhD scholars, post-

doctoral fellows, masters students and professors. Stating that I breathed and lived research is not an exaggeration, as I spent around 18 hours per day in the lab and lab corridors.

Entry into a Hospital

After continuously working, breathing, sleeping, and living in academia, recently I joined as a Scientist in the KMCH Research Foundation affiliated with Kovai Medical Center & Hospital, Coimbatore (a NABH accredited multi-speciality private hospital) to establish my own independent research career. Here the environment is entirely different and I am surrounded by physicians, nurses, post-graduate medical students, and administrators.

Every day before entering the lab, I have to cross the sorrowful, worried, tearful faces of patients and their relatives. So, it is important that I have to be mentally strong to get back to my work after witnessing such distress. On the other hand, these moments had motivated me to do translational research along with basic science to relieve and counter their distress.

Hospitals and Research in India

The clinical set-up in India is entirely different from western countries. In the western world, research labs are largely linked with hospitals and it is quite common to see research faculty with an MD degree. But in India, the medical science and clinical research communities are rather separated and there exists little to no involvement of physicians in research.

As per my experience, the main contribution of Indian physicians to research is facilitating access to clinical samples and patient data. It is not that physicians in India do not have a passion for science; rather, except for a few, most of them lack sufficient awareness of science. But it is not wise to simply blame physicians for not getting involved in research. The total number of patients (emergency, inpatient, and outpatients) that Indian physicians have to take care of is very large and we cannot deny that their working time is dedicated almost completely to this noble lifesaving cause.

In fact, the number of physicians per citizen in India is still not comparable

to developed nations. As per WHO data (2017) on health workforce, India ranks 136th in the world with less than one doctor per 1000 patients. It is unfortunate that medical institutes like All India Institute of Medical Sciences (AIIMSs) and medical universities have less or no connections with scientific institutes like the Indian Institute of Science (IISc), Indian Institutes of Science Education & Research (IISERs), Indian Institutes of Technology (IITs) and state and central universities. As I witnessed, even exceptional physicians with a real passion for science do not find time to read articles and perform research work. At this situation, it is the duty of the basic scientist to act as a bridge between scientific research and clinical practice in India.

Advantages of doing research in a hospital

The primary advantage of doing science in a hospital is the ease of access to clinical samples with complete patient data, which is a big challenge for researchers working in universities and research institutes. In addition, by direct interaction with the physicians, nurses, and patients as well as day-to-day observation, I understood some real problems associated with various diseases.

All over the world, there exists a strong barrier in taking the outputs from the lab-bench to the clinical bedside. This lapse can be rectified by combining basic research with the clinical environment. Hospitals often have huge manpower in the form of medical post-graduation students, nurses, and lab technicians and have good clinical biochemistry laboratories with sophisticated and automated instruments for clinical measurements. However, it is important that these resources are utilized sensibly for my research work in a way that does not hinder normal hospital activities.

Yet another advantage of doing science in a hospital is that there is no need to be completely dependent on government agencies for funding. Every pharmaceutical company has a mandate to provide funds for charity/basic research that is unrelated to their products (to avoid conflicts of interest). It is far easier for the physicians (as compared to basic scientists) to get funds from these resources. For instance, I was recently denied an international travel grant from a national funding agency and got only a partial travel grant

from another national funding agency for participation in an international conference. At this juncture, the physician and president of our research foundation acted immediately and managed to get funds from a Pharma company to cover my international travel.

Challenges of doing science in a hospital

There are many challenges and barriers to executing science in a hospital environment. Pursuing a scientific career in a private hospital is not at all possible without the support of administration and physicians. In my case, I am fortunate to have both the chief administrator and a group of physicians with real passion for research. In other places, it is possible that administrators may view research activities with a money-based profit mindset, which will not work for science.

Another important mandate for working in hospital is that the researcher must have moral and social values. Interactions and interventions with the patients, physicians, or nurses should in no way affect their day-to-day work, which may, in turn, reflect on the morbidity and mortality of patients. So, it is very important to make sure that none of my research activities disturb their medical efforts and duties.

The space required for a physician for consultation is relatively small in comparison to a research laboratory. So, getting lab space is the most challenging aspect of working in a hospital and it completely depends on my performance as assessed by the generation of data, publications and procuring of grants.

The protocols in a hospital set-up can be really complicated, weird, and unusual for an academic researcher. Among them, the funniest, as well as one of the most deeply troubling aspects, is that the time of work is allotted in shifts, as applicable for physicians, nurses and other hospital staff. An academic researcher usually works around the clock, thinking, writing and executing experiments.

In addition, words like “shift time”, “punching”, “HR”, “manager”,

"income tax", etc. still sound strange to me. Another peculiar challenge is that I often get requests from relatives and friends to get appointments and medical advice from physicians in our hospital. While this can't be ignored completely, it has to be dealt with judiciously based on whether the patients are critically ill.

On understanding the advantages of doing science in a hospital, the challenges and hurdles seem tiny. I am very hopeful that in due course, all of these hurdles will either be solved or I will become more used to prevailing protocols in hospitals. Altogether, I am slowly acclimatising to the hospital-based research atmosphere and genuinely believe that I can play a small but significant role in bridging the gap between the lab bench and clinical bed.

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Pursuing Science at a Liberal Arts University

Shivani Krishna

I had never been fully exposed to a liberal arts education system before I joined Ashoka University, Sonipat. Today in India, along with Ashoka, we have a few renowned universities such as Azim Premji University, Bengaluru, FLAME University, Pune, and OP Jindal Global University, Sonipat, that provide liberal arts education. Liberal arts education primarily aims at understanding how the world works and encourages students to think critically about real-world issues.

Often, traditional barriers between disciplines hinder us from tackling large scale environmental, economic, and health problems. Breaking these barriers and providing students with a holistic education is crucial in today's world where scientific research cannot work in insularity but has to be communicated and implemented in the right way for impactful solutions. It was only when I started teaching that I realised the advantages and challenges of teaching science, especially biology, at a liberal arts university.

Before moving to India, I was working for long hours with bumblebees in the lab and the field to wind up my postdoctoral work. Soon after I joined Ashoka, I started preparing for my lectures and began looking out for plant

and animal systems in the vicinity for practicals. When it comes to student learning and responses in classroom lectures, there is not always a close match between our imagination and reality. My experience was no different. I prepared thoroughly for the first few lectures but after my first class, I decided that something has to change. For example, the diverse backgrounds of the students required the concepts I taught to be free of jargon and Latin names/taxonomical details of plants and animals.

I taught a theory course in ecology and co-taught a lab course in ecology and evolution with a colleague in the department. I found out that students in my class had not only learned genetics and microbiology but had also taken courses in economics, political science and psychology. I liked the challenge of teaching students whose way of thinking was different from mine. I tried making my classes interactive (and I believe I succeeded to a certain extent) and I used a variety of approaches to teach them ecological concepts. As part of these discussions, I have learnt that economics and ecology have several theoretical models in common and that experimental approaches are very different in sociology. Overall, I encouraged the students to think about how to design experiments to test a particular theory and how to make sense of the data once they have done experiments.

Students that I taught were in their final year (upper level) undergraduate degree and I could, therefore, test them for higher-order thinking skills. These skills can help them dissect any issue analytically, be it in psychology or physics. Many of them want to go ahead and apply for graduate schools, while some of them want to do a master's program in their field of interest. While they feel occasionally threatened by the large number of specialised courses that students from more traditional higher education systems take, I try to reinforce that while they may not know the breadth of jargon, they are fully equipped to think of any real-world scenario analytically.

Addressing such concerns and answering the students' queries about choices of courses was something I was not fully prepared for. I prepared myself by reading about the diversity of pedagogical methods across the world and how curriculums have been evolving in other parts of the world

to incorporate the needs of today's emerging problems whilst catering to internet-savvy students.

Also, while I was thrilled about the diverse backgrounds of my students, the practical course was a challenge. It was not easy bringing them together to do experiments which involved teamwork. Since these students each take a variety of courses, they don't have close ties between themselves. In addition to that, finding time to work on group projects was a challenge, and it took them a while to find solutions where they had to work outside the campus on field projects. Real-world research requires team effort and through the practical course, I was also trying to teach them how to work together on a research project.

I did not succeed in my first attempt, where I asked the students to divide tasks between themselves. In this case, they simply failed to complete the practical as a group. This was largely a consequence of them being used to learning in isolation after-class (although the upside of this is that they are involved in more exploratory self-learning). In the next session, they devised ways to communicate amongst themselves and emerged as a successful group.

I have two undergraduates who are majoring in biology and two undergraduate students majoring in physics who have started to work on small research ideas independently. Their strength lies in their ability to think beyond biology and physics. While I want them to be involved in meaningful research, they struggle to find time and switching between different kinds of interesting things that they have on their plate has not been easy. Incorporating research work as part of a course where students spend the first half of their semester learning the theoretical concepts and the second half working in a related lab would be one way to avoid this struggle.

Like any other research university, we are assessed for our research, teaching and service. In the first semester, I put in more time for teaching alongside writing up grants and analysing data from my previous research. I recruited a research assistant and initiated the process of scouting for potential field sites where I can start my research on understanding how different floral features such as colour, shape, and size influence animals that interact with

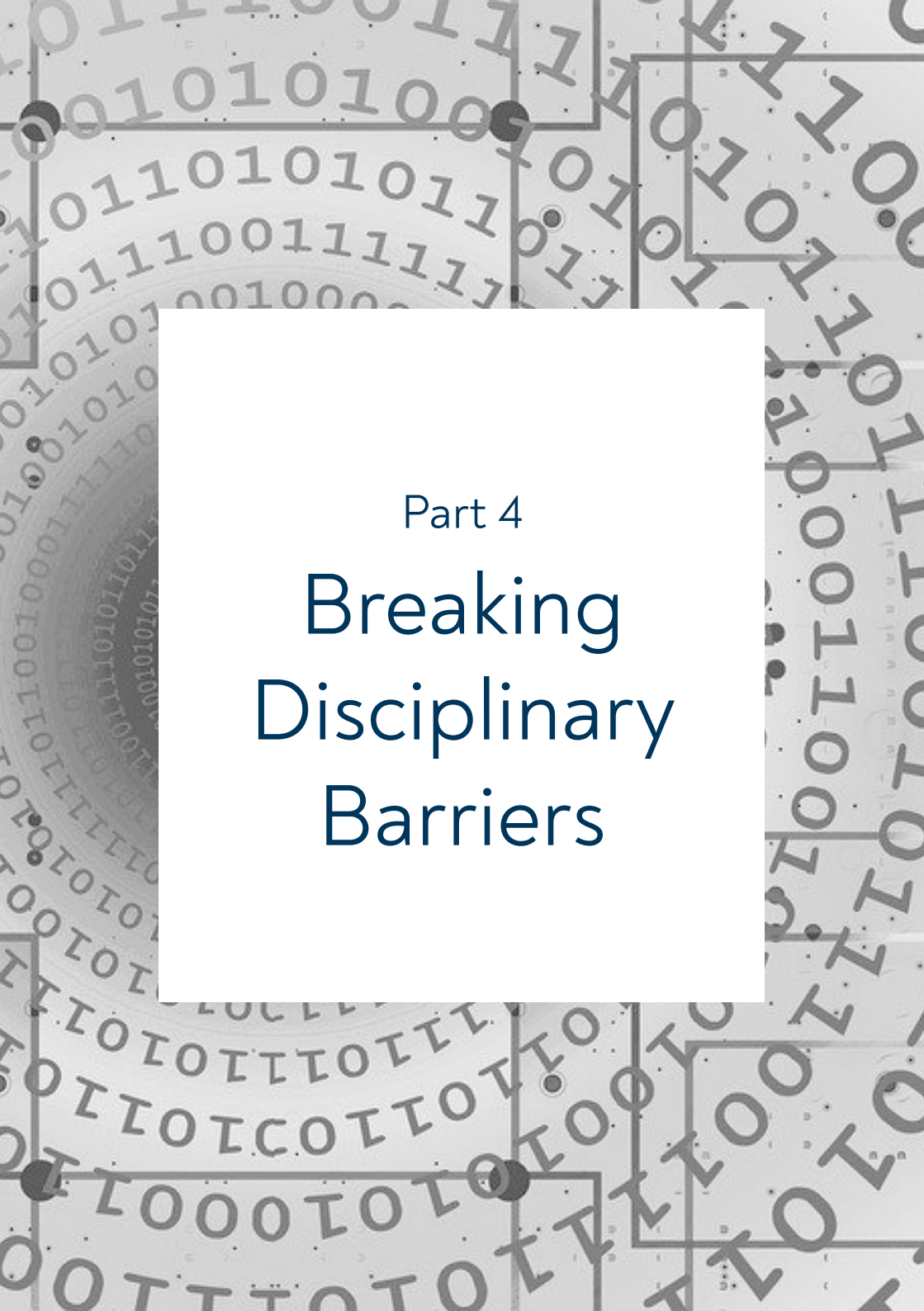
plants positively and negatively (such as herbivores that eat plant parts) in a semi-arid community.

I have a fond memory of working with undergraduates from different disciplines during my time as a PhD student at IISER-Thiruvananthapuram. Learning to speak the distinct languages of different disciplines within the sciences was a challenge at that point in time. But that challenge now seems much smaller when I sit in a faculty meeting at Ashoka where the room has members from economics, anthropology, or performing arts. There is a newfound joy in knowing that you can take a problem, analyse it, find a comprehensive solution, and finally implement as well as communicate every aspect of it meaningfully, when the people in that room work together.

One of the most important suggestions I have for those planning to be part of liberal arts universities is to understand the educational system well before joining. The rigour and demands in terms of research are no different from a traditional place but the emphasis on teaching is much more. Teaching and research with undergraduates is a crucial component of the system.

I volunteered and learnt different pedagogical methods during my postdoctoral work at the University of Haifa, Israel where they have a training facility for teachers and this has been a beneficial experience. One can also prepare themselves by applying innovative pedagogical tools developed for teaching sciences. I constantly keep myself updated with new hands-on activities, interesting case studies, and innovative research articles that have multi-pronged approaches to address critical problems in the field.

Shivani Krishna is an Assistant Professor at Ashoka University, Sonipat.



Part 4

Breaking Disciplinary Barriers

Journey of a Population Geneticist

Pursuing a less popular field of research

Ranajit Das

As a subject, biology was not my first love in school. Rather, it had always come a close second to mathematics and statistics. As I progressed through higher education, I realized that this wasn't a particularly desired combination of subjects to love and pursue. With all the boxes drawn around education and career paths, the duo of math and biology seemed to 'fit' in very few of them, if at all.

I pursued BSc (Hons.) in Zoology at Presidency College, Kolkata (now Presidency University), one of India's oldest and most prestigious colleges. Here my passion for life sciences blossomed. But thriving at Presidency and doing well in terms of grades had its own pitfall as I subsequently and somewhat mindlessly followed the herd of social expectations and ended up pursuing MSc in Biotechnology at Ballygunge Science College, University of Calcutta.

I soon realized that as a subject, biotechnology was not my cup of tea and I yearned for a way out. Soon afterwards, I got an opportunity to do a Masters in Zoology at Southern Illinois University Carbondale (SIUC), USA, with full financial support. Pursuing Zoology once again felt like coming home.

It was here at SIUC that I was introduced to population genetics as an independent subject and research area. I was thrilled to find it an area of scientific inquiry that combined my two loves – biology and mathematics/statistics – and realized that this was likely the field in which I would want to base my future research endeavours.

Meanwhile, I got married and at the time my wife was working on her PhD in Pittsburgh, USA. I wanted to move to Pittsburgh for pursuing a PhD, but it proved to be tricky given the dearth of labs focussing on animal-based evolutionary and population genetics in the city. I found myself in a sticky spot but soon discovered the lab of Michael Jensen-Seaman at Duquesne University, a comparatively newer university at Pittsburgh, who had been working on primate molecular evolution and population genetics. I joined his group and both my thesis work and a wide array of coursework I undertook in biostatistics, human evolutionary bioinformatics and population genetics at Duquesne as well as the University of Pittsburgh fostered my interest in the area at large.

Post PhD, I moved to the UK, where I began postdoctoral research at the University of Sheffield, delving into human population genetics using a variety of biostatistical and bioinformatics approaches. I had always been keen on moving back to India to set up my independent lab. An opportunity appeared almost out of the blue about a year and a half into my postdoctoral work, when I received an offer from Manipal Academy of Higher Education (MAHE), Manipal, Karnataka. I accepted the offer and returned to India after almost eight years of life and education abroad, having imbibed the flavours of research and academic traditions of two continents.

I was thrilled at the prospect of beginning an independent research career in population genetics in India but soon realized that this was going to be an uphill task, since most scientists, as well as science/education administrators, were either unaware of the subject or appeared reluctant to offer it as a mainstream research branch under life sciences. And this is not country- or region-specific – I had encountered this even in course of my academic training. It is only in a few universities worldwide that population genetics

exists as an independent discipline of investigation. A major reason for this is the lack of awareness regarding the impact of population genetics in healthcare, pharmaceuticals and biodiversity conservation.

The question I get asked all the time is: What is population genetics and which branch of biology does it fall under? Does it come under genetics, evolutionary biology, medical genetics, human genetics, or biodiversity conservation? The simple answer to this is that it can be included with and applied to almost any problem in biology. As a matter of fact, population genetics is the face of evolution at the population level, depicting genetic variation among populations both spatially and temporally. And as Theodosius Dobzhansky, a geneticist and evolutionary biologist famously said, "Nothing in biology makes sense except in the light of evolution."

In the course of my academic training and during my independent research career, I have worked with scientific problems and questions looking at population genetics in various systems, including birds, non-human primates, humans and even insects. Given this, another question/criticism I face continuously is: What is your study system? Humans or primates or something else? The answer is that I am not restricted to any one model system. Being a population geneticist, I am open to working with any organism within the tree of life, as long as the research question and problem is interesting.

Needless to say, being products of a not-so-flexible educational system, where people are generally used to compartmentalizing, every subject including biology and science, in general, is usually confined to a predefined perimeter. As a result, I have struggled to convince other scientists, academicians and education administrators that my research may well include humans, apes, monkeys, and tigers at the same time, without diluting its depth, importance and utility.

In working towards finding my identity and feet as an independent researcher I have found my research area in population genetics also struggling for acceptance. While some clinical geneticists wanted to exclude it from their purview because in their opinion the field was too anthropological in nature,

some biological science departments felt the contrary and found my research too focussed on human genetics. Some thought I had my fingers in too many pies working on multiple organisms. Overall, I was constrained by a myopic view of research that failed to envision the enormous possibilities in inter- and cross-disciplinary studies, and the tremendous prospect of combining population genetics with biomedical, pharmaceutical and biodiversity conservation research.

I strongly feel that this narrow-minded approach towards life sciences has increasingly become detrimental to the subject. Today in India and worldwide, biology is fast becoming synonymous to biochemistry, cell, developmental and molecular biology, and biomedical sciences. As a result, less highlighted areas of research such as population genetics (except perhaps human population genetics) are in many instances being pulled out of biological sciences and being grouped under environmental sciences. Our utilitarian outlook and the increased focus on encouraging and funding research that supposedly ask scientific questions with greater translational value (e.g. those offering to solve 'important' problems in healthcare and climate change/conservation) have disparaged the so-called more theoretical areas such as population genetics, without realizing the value the latter may have otherwise added to the some of the very problems we seek to solve.

Eclipsed by its 'big brothers' in biology, population genetics as a field also struggles with lack of takers. Students are often reluctant to join a lab focusing on a largely theoretical subject because of two major reasons. First, despite having immense potential in the realms of healthcare, population genetics research has remained largely at the fringe and does not seem immediately translatable in providing an overtly visible benefit to humankind. Second, till date, population genetics has not looked promising from a commercial standpoint when compared to other fields in biological and pharmaceutical sciences that have a higher potential to land students a better job.

However, it is not all grey and gloomy as a population geneticist. My personal attempt to survive and thrive has involved trying to bridge the theoretical core of the subject to more practical aspects, for e.g. variation of

disease susceptibility across populations over time and space (for humans) and biodiversity conservation (for charismatic endangered animal species). One can also redefine the term 'population genetics' according to the research question at hand and the same subject can become human genetics or conservation genetics depending on where and how it is being used.

My journey as a population geneticist and evolutionary biologist has been one of following my heart, and despite its trials and tribulations, it has been enriching and rewarding. And recently I have joined Yenepoya (Deemed to be University) at Mangalore where I continue the process of setting up my research group in population genetics. I believe in a world without demarcations and constraints, in life as well as in scientific pursuit. And I believe that it is only through free thinking and applying ourselves to address questions that are meaningful to us without being curbed by pre-existing notions, shall we progress towards building greater knowledge.

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An Engineer's Winding but Rewarding Journey into Biology

Sreenath Balakrishnan

Research has become increasingly interdisciplinary and an exciting multidisciplinary field is bioengineering. Research in this area over several decades has produced many applications such as medical implants, engineered tissues, and brain-machine interfaces. The current excitement around synthetic biology and artificial cells further necessitates the infusion of engineers into life sciences. However, the number of engineers trained in traditional disciplines such as mechanical, electrical and computer science venturing into bioengineering remains abysmally low, especially in India. By sharing my meandering journey, I hope to convince young engineers to become bioengineers and allay the insecurities of those in the making.

My first impressions of biology were repulsive. As a child, the suitcase full of thick books that my brother, who was ten years elder to me and pursuing medical school, brought home during his vacations sounded an early alarm. Having to remember many facts and names further alienated the subject and I chose computer programming over biology during my higher secondary.

Later, while pursuing a BTech in Mechanical Engineering, I had my first tryst with biology during an unsuccessful attempt at creating a bi-pedal

walking mechanism. Naively, a friend and I hooked up four motors to a frame for replicating the two hip and ankle joints. When the robot couldn't balance, we realized a subtle aspect of walking. Before lifting a leg, our hips move laterally to shift the centre of gravity above the other leg, which is on the ground. After BTech, I worked for two years with Larsen and Toubro, wherein I got a once-in-a-lifetime opportunity to be part of the team that built INS Arihant, India's first indigenously-built nuclear submarine.

Subsequently, I moved to Virginia Tech for their master's program in Mechanical Engineering. I secured a research assistantship position with Rolf Mueller who was working on echolocation in bats. We studied a fascinating behaviour in horseshoe bats – they actively deformed their outer ears while echolocating. My contribution to this project was a digital model that mimics these motions. During the project, I developed an interest in biology, which was further piqued by a graduate course on bio-inspired technology taught by Mueller. I also realized the passion with which people work in academia and started considering becoming a faculty. Here was a job that pays you to do what you like to do!

After completing my master's degree, I took a detour from research and decided to pursue a life-long dream of working on a socially-relevant project in India. After several interviews, I chose the MindTree Foundation and joined a project for enabling computer access for people with motor disabilities such as cerebral palsy. By the time I joined, the team had decided to develop a device for recognizing hand gestures and had built a glove fitted with accelerometers. I was entrusted with creating an algorithm for recognizing gestures from the accelerometer signals.

After poring over various machine learning techniques over several months, I reverted to mechanics and modelled fingers as linkages. I used inverse kinematics, a technique to analyze linkages, which I had learned during my bachelor's degree. Looking back, I can relate one of my favourite quotes by G.K. Ananthasuresh, my then-future PhD advisor, "Your undergraduate education always stays with you." By the time I successfully demonstrated the algorithm, the Foundation was on the verge of closing due to troubles in its

parent company, Mindtree Ltd., and had to discontinue this project.

Stung by this setback, I returned to academic research and joined G.K. Ananthasuresh's lab at the Indian Institute of Science (IISc), Bengaluru, as a research assistant. Time spent on the beautiful IISc campus cemented my aspirations to become a faculty. I had decided to apply for a PhD position in IISc when a poster on my lab notice board caught my attention; it was for a new PhD program in Bioengineering.

All my past experiences, bi-pedal walking robot, modelling bat ears and hand gestures seemed to align with this program, and I instinctively applied for it. My interviews went well, and I was selected among the first batch of bioengineers at IISc. Our batch had a healthy mix of biologists and engineers, and the program was carefully designed to complement our previous training through theory and lab courses.

I had chosen to work on the mechanical properties of liver cells with Saumitra Das in microbiology and G.K. Ananthasuresh in mechanical engineering. In my first interaction with Saumitra Das, he gauged my apprehension and told me that "Biology taught in class can be boring, but practical biology is exciting." This vindicated my initial discomfort with biology which had subsequently changed to enthusiasm. I decided to embrace the subject rather than shy away from it.

Even though I had started to understand the subject from my batchmates and lab meetings, I still found the descriptive nature, without quantitative principles, of standard biology textbooks such as Campbell's and Lehninger's unsuitable to my taste. Luckily, I found 'Physical Biology of the Cell' by Rob Phillips, which introduced biology from a physical and quantitative viewpoint using principles such as energy, entropy and diffusion. The book followed a novel approach of introducing biological systems and processes based on their physical proximity such as length and time scales, and energies involved. This fascinated me and even helped me clear my comprehensive examination!

My research started in the usual way engineers are expected to contribute in

biology, by building experimental tools and methods. I developed a perfusion culture system, for culturing cells under flow, and coded image processing algorithms for obtaining the geometry of the nucleus from microscopy images. By using these techniques, I made a primary observation that liver cells with Hepatitis C Virus have larger nuclei than normal liver cells.

While I was progressing with biochemical and biomechanical experiments for understanding the molecular mechanisms responsible for this phenomenon, a question by G.K. Ananthasuresh intrigued me. He asked whether I could discern the molecular mechanism from just the changes in nuclear shape. This innocuous query took me on a ride to understand the cell and nucleus as a mechanical structure and further model the nuclear envelope using mechanics of membranes. I was elated when the predictions from my model matched with experiments.

Soon after defending my PhD thesis, I applied for faculty positions and got recruited at the School of Mechanical Sciences at Indian Institute of Technology (IIT) Goa.

From my experience, the biggest hurdles bioengineers face are insecurities, such as will I ever be able to master biology, do I know enough about the subject, and am I foregoing all my previous expertise. Here are some suggestions from my limited experience and wisdom to overcome them:

- Learn the subject from a book that takes a physical approach to biology such as the 'Physical biology of the cell' by Rob Phillips and 'Biological Physics' by Philip Nelson.
- Discuss science with your peers, particularly people with a biology background. Lab meetings are especially helpful because you can understand the way biologists think and how they design and refine their experiments.
- Make many presentations, especially to critical senior faculty in life sciences. Their questions will help you design your controls better, which will be invaluable when you are publishing.

- Develop a unique viewpoint to your biological system aligned with your basic training. While I would relate to cells as mechanical structures, electrical engineers can view the nervous system as a network or circuit, chemical engineers can imagine cells as chemical reactors and for computer engineers, the cell could be an information processor. From this unique viewpoint, apply physical principles and techniques developed in your discipline to the biological system, which can be used, among many other things, to enhance experimental observations and discover mechanisms. In my opinion, the insight obtained from applying physical principles to their unique viewpoint would be the greatest contribution by bioengineers.

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Equations to Evolution

My journey in interdisciplinary research

Krishna Swamy

I was always fascinated by wildlife and biology had a special place in my heart during my school days. However, the quantitative perspective gained from physics out-competed the qualitative perspective of biology and led me to a masters in physics.

I came to know of the quantitative side of biology from my biophysics course during my master's studies. It was deciphering and finding solutions for complex systems that drove my passion for science. For some time, I was torn between cosmology and biology. My inadequate knowledge of biology held me back and led me to pursue cosmology instead. After a short stint of graduate-level research in cosmology and a lot of reading in biology I realized that my true calling was in biology, also a complex system with applications that can be perceived more easily compared to theoretical physics.

I joined MRN Murthy's lab at the Molecular Biophysics Unit at the Indian Institute of Science as a research fellow and was introduced to the world of proteins, their structure, and how their function depends on their conformation. MRN Murthy encouraged me to harness my mathematical skills and develop computational methods for protein sequence and structure

analysis.

Soon I started working independently on evolutionary analysis of proteins and comparative genomics to understand why or how organismal complexity arises. I realized that although proteins are the workhorses of the cell, the complexity of an organism does not linearly increase with the number of protein-coding genes in the cell. In fact, the way protein-coding genes are regulated is significantly correlated with a higher fraction of the noncoding regions of a genome in the organism (proposed by Michael Lynch).

I wrote to Wen-Hsiung Li in Chicago with the results from the above analysis and got a PhD offer. Li had two labs - one at Chicago and another at Academia Sinica, Taiwan. He convinced me to come to Taiwan, as he had better infrastructure and facilities there. Coincidently, my physicist wife had also found a postdoctoral position in Taiwan. I did my PhD in computational biology from the Institute of Information Science, Academia Sinica, Taiwan.

I was lucky to work with Huai-Kuang Tsai, a young and dynamic PI and a former postdoc of Wen-Hsiung Li, who had set up his own computational biology lab. During my PhD I developed methods to analyse and predict the structural, functional and evolutionary aspects of noncoding regions of the genome important for mediating transcription in yeast, Drosophila, Arabidopsis and primates.

During my PhD, I realized that experiments play a key role in understanding biology. I transitioned from a theorist and computational biologist into an experimental biologist as a Distinguished Postdoctoral Fellow in Jun-Yi Leu's lab at the Institute of Molecular Biology, Academia Sinica, Taiwan. Here, I developed computational methods and designed experiments to decipher the molecular mechanisms of speciation, the evolution of complex traits such as fermentation in yeast, and the evolution of co-operation.

I have been lucky for having the support of my postdoctoral advisor, Jun-Yi Leu, especially since I was doing experiments for the first time in my life. He gave me leeway and taught me well enough that I could set up an experimental molecular biology lab of my own. After seven years of postdoc,

I joined the school of arts and sciences at Ahmedabad University as an Assistant Professor in March 2019.

Here is some advice for conventionally trained biologists aspiring to do interdisciplinary research:

- *Be open-minded:* You might be required to change the way you think when using or developing a mathematical and computational model. Systems biology, for example, usually involves a fair amount of computation and experiments. Although both molecular biology and systems biology can answer the same biological questions, they do it in different ways. While systems biologists try to arrive at the underlying principles between genetic interactions responsible for a phenomenon, they might not arrive at the molecular mechanisms of a specific genetic interaction, which traditional molecular biologists strive for. Findings in systems biology (like computational biology) could be derived from statistical and mathematical models, and sometimes, direct experimental validation might not be feasible. A lot of relearning might be needed if one is new to mathematical and computational modelling and is handling whole genomic or transcriptomic datasets.

- *Index reading:* Time spent on learning certain concepts and basics will go a long way. Although it might seem that there is an ocean of knowledge out there, index reading (reading the required sections by looking it up in the back-of-the-book indexes) serves for most practical purposes.

- *Do not hesitate to ask for help:* While you can pursue a new field independently, it is good to partner with a person with considerable expertise in the new field for the first few projects, till you learn the ropes of the trade. You could also reach out to other people working in the field. Although they might not work on your problem, they can help in overcoming hurdles by discussing them with you.

- *Attend meetings and conferences:* This is probably the most important factor. Speakers in meetings and conferences usually provide distilled information from several years of research. It also helps to know the

recent advances even before they are published. Conferences are also probably the best venue to network and find future collaborators.

While traditional molecular and cell biology are evergreen fields and required for determining molecular mechanisms, having expertise in multiple disciplines has its benefits. It can help in addressing problems at a systems level and in deriving general solutions applicable across species which might not be feasible by traditional biological techniques.

However, it can come with a trade-off in the depth vs breadth of one's knowledge. Such a trade-off is also true for the scientists' grasp of knowledge in different fields. Hence, interdisciplinary research is best conducted in a collaborative set up. YIM is one such venue for young PI's (like me) to network and build long-term collaborations.

Krishna Swamy is an Assistant Professor at the Division of Biological & Life Sciences, Ahmedabad University.

Part 5

Off the Beaten Track

Journey from a Small Village in Assam to the Exciting World of Science

Pankaj Barah

I was born in a small and remote village named Borbali in Assam, situated on the foothills of the Himalayas in the beautiful north-eastern part of India (NER). Since my childhood, I have always been inclined towards the beauty and organizational complexity of nature. Perhaps the tranquillity of nature around me had nurtured my scientific curiosity from an early age. I often used to go out to the forest collecting wild fruits, taking pictures, collecting plants for my home garden, joining senior researchers in their field trips, writing popular science articles in local newspapers and magazines, visiting schools and villages to organize awareness camps for nature conservation etc. Owing to a tremendous curiosity towards nature, I chose biology as my major during my undergraduate studies.

I studied in a vernacular medium school in the village up to the 10th standard. I had to walk 4 to 5 kilometres daily to my school barefoot through paddy fields. Many times, I used to stop in the middle of the road and stare at the activities of beautiful insects, butterflies, birds, as well as the fish in the stream. Perhaps we were the lucky generation before the arrival of smartphones, internet, or even cable TV, since we could spare time to enjoy the wonders of nature. I moved to the nearby town for my 10+2 studies and

subsequently relocated to the city of Guwahati for my undergraduate studies. It was a big leap for me and I began adapting to the concrete jungles.

During my undergraduate studies (2000–2003), I was thrilled to read about the advancement of genome technologies in local newspapers. We did not have access to the internet at that time. The first draft of the Human Genome was just published around that time. I authored a science fiction story for our college magazine. The story described a dream where I was working with Fred Sanger.

To my surprise, it became a reality in 2010. I was fortunate to meet Sanger in Wellcome Genome Campus, in Hinxton UK, during an advance-training course at Sanger Institute. The experience of meeting and having dinner with Fred Sanger on the occasion of celebrating the 10th year of publication of the first draft human genome still remains like a dream for me. It was nearly an unbelievable experience for a boy like me coming from a small backward village in Assam. I realized that nothing is impossible in life—"If You Can Dream It, You Can Achieve It".

During my BSc days, I developed a tremendous interest in exploring the developments in modern genome technologies. I was staying with one of my cousins in the Indian Agricultural Research Institute (IARI) campus in Pusa, New Delhi, for nearly a month just after my BSc exams. During that stay, I got the opportunity to visit modern molecular biology laboratories in IARI and Delhi University South Campus for the first time in my life. The desire to see myself working in such a laboratory grew and I joined the University of Madras for pursuing a master's degree in Bioinformatics.

I received interdisciplinary training in both molecular biology and computational biology during my MSc. I did my masters project in two world-class institutes in India—National Centre for Biological Sciences (NCBS) and Indian Institute of Science (IISc) in Bengaluru. It was an excellent opportunity for me to get exposure to cutting-edge research areas in the field of modern biology. During my master's internship, I worked on protein sequence, structure, function and evolution in highly divergent protein families. That was the turning point in my scientific career.

After completing my master's degree, I worked in a software company and in two national research laboratories in India for three years. Initially, I worked as a Junior Research Fellow (JRF) at the Bioinformatics Centre, University of Pune for a year with a fellowship granted by the Department of Biotechnology (DBT), Govt. of India. Later, I moved to the Mathematical Modelling and Computational Biology Group at the Center for Cellular and Molecular Biology (CCMB), Hyderabad. I was also successful in receiving a Senior Research Fellowship (SRF) in trans-disciplinary areas from the Council of Scientific and Industrial Research, Government of India.

The field of systems biology was evolving very fast. I received an offer from Norwegian University of Science & Technology to join as a PhD fellow in an exciting systems biology project (ERA-NET MultiStress) being conducted collaboratively at several universities in Europe. I worked closely with experimental biologists in a mega-scale project. I received training in modern OMICs technologies, as well as computational modelling tools during this period.

During my PhD, I visited reputed labs, universities, institutes in the Netherlands, United Kingdom, Belgium, Denmark, and Italy, interacting with researchers from diverse backgrounds. It gave me not only multidisciplinary training but also provided me with the opportunity to work in multicultural, multinational, and multitasking environments. I carried out my PhD research at the Norwegian University of Science & Technology in Trondheim, Norway to defend the thesis 'Integrative Systems Approaches to Study Plant Stress Responses' in April 2013. I used high-throughput data — transcriptomic, metabolomic, genomic — along with many computational tools to investigate intraspecific natural variations in plants while responding to a diverse range of environmental perturbations.

During my first postdoctoral period (2013–2015) in Norway, I explored how molecular changes in the so-called junk part of the plant genome might play a crucial role in local climate adaptation and phenotypic variation in plants. For this work, I developed collaborations with R. Sowdhamini's lab in NCBS Banglore, India (later published in the journal Nucleic Acids Research

in 2015).

In 2015, I moved to Heidelberg, Germany to work as a Bioinformatics Scientist in the eMed-Bio Systems medicine project 'Systems-based predictors for the biological and clinical behaviour of gliomas (Sys-Glio)'. This work was part of the International Cancer Genome Consortium (ICGC), as well as the Heidelberg Center for Personalized Oncology (HIPO) projects to develop efficient, cost-effective treatment strategies for individual cancer patients. During this tenure, I worked in the Computational Oncology Group under the Division Theoretical Bioinformatics at German Cancer Research Center (DKFZ).

My work from the Sys-Glio project was published in the journal Cancer Cell in 2019. We could show through Big data analytics and mathematical modelling of matched pairs of primary and relapsed tumours based on deep whole-genome-sequencing data from 21 patients, the origin of de novo glioblastoma, up to 7 years before diagnosis. We also identified a common path of the early process of cancer development and a novel mechanism for early tumorigenesis in IDH(WT) Glioblastomas.

The Sys-Glio project gave me the unique opportunity to work in a highly interdisciplinary and translational research environment. Additionally, the vibrant academic and scientific environment of the city of Heidelberg has enriched my life and career in diverse ways.

I was looking for opportunities to come back to India, more precisely to North East India (NER) for two reasons-

1. I felt that there was tremendous opportunity to explore natural and biological complexity in this region.

2. I felt that it was a necessity to contribute towards human resource development in evolving areas of modern biology.

I was fortunate to receive a permanent faculty position at Tezpur Central University, one of the premier institutes in India. Within a few months, I was awarded the Ramalingaswami Re-entry Fellowship by the Department

of Biotechnology, Government of India. The beautiful campus of Tezpur University situated amidst tranquil nature took me back to my childhood days. The vibrant interdisciplinary environment and world-class infrastructure gave me the opportunity to take initiative to fulfil my dreams.

I was fortunate to receive generous grants from funding agencies such as DBT, SERB and collaborative supports from experts from diverse areas in local institutes. I have also been able to develop collaborative research projects of local interests with several interdisciplinary research groups in the NER.

Teaching and other administrative responsibilities become a priority for a newly joined Assistant professor at an Indian University. On one hand, it may look like a setback for one's research career. Of course, one has to compromise on the amount of time spent on research. However, on the other hand, the continuous flow of hundreds of students every year keeps us rejuvenated with new hopes as well as new ideas. Availability of scholars from diverse disciplines within a single campus provides an opportunity for interdisciplinary collaborations. However, I feel that there is still scope for providing special considerations for young PIs in the University system. A performance-based reward and promotion system should also be considered.

My advice to young researchers would be to avail of national and international mobility grants to enrich experiences. There are several mobility grants available at both national and international level. Young researchers must be flexible in choosing their research problems. Being rigid and possessive about a single research idea may lead to difficult situations in future. Keep yourself well updated about the recent trends in research areas and visualize what is going to come in the next ten years. Prepare yourself well in advance to adapt to future developments. I agree that Science Knows No Boundaries. At the same time, we must prioritize addressing some of our local or indigenous problems with our international experience and cutting edge technologies.

I have evolved from a boy once roaming freely and happily amidst nature to a young investigator leading my own research group today after gaining

more than a decade of interdisciplinary research experiences. During this period the approaches of my research have constantly been evolving while trying to understand the evolutionary complexity of nature from different angles. I am very optimistic that through my scientific endeavours I will be able to contribute to solving some of the need-based problems of NER, for the nation as well as for humanity.

I conclude with the following quote -

"One thing: you have to walk, and create the way by your walking; you will not find a ready-made path. It is not so cheap, to reach to the ultimate realization of truth. You will have to create the path by walking yourself; the path is not ready-made, lying there and waiting for you. It is just like the sky: the birds fly, but they don't leave any footprints. You cannot follow them; there are no footprints left behind."

— *Osho*

Pankaj Barah is currently working as Assistant Professor & DBT-Ramalingaswami Fellow at Tezpur University, Assam.

The Rocky Road to Academic Bliss

Meghna Krishnadas

I am an accidental academic. This career had never been mooted by the wise elders of my extended family comprising many doctors and a motley crew of the usual vocations. My parents, a teacher and a geophysicist, agreed with received wisdom that medicine was a good (and safe) choice for a kid who liked biology.

Midway through med school, I went walking in a forest. To this day, I know not what it woke in me — there was always an inherent curiosity — but the natural world captivated me. A conventional career in medicine was not my calling. Volunteering for wildlife research organizations opened my eyes to the possibility of studying ecosystems as a systematic science. I had a medical degree but was hooked to ecology. After stints as a doctor in remote forest areas, I eventually decided to do a Master's in Wildlife Biology. Today, with a PhD in Ecology, I like to say that I left the hospital halls for the forest trails, and it's been a good walk.

You might be wondering why I recount the story of my meanders into the sciences. Well, because I exemplify the case of one falling in love with science relatively late in life. I never planned for academia but also never saw my

circuitous path there as a problem. I believed that my unusual background would be an asset, bringing in a rich palette of learning. I was confident that my interwoven tapestry of experiences would stand me in good stead, alongside good science, in running a lab where so much was about managing people and unexpected situations.

Until I started looking for a job in India.

After a fulfilling PhD at Yale, working in a great lab with an excellent advisor, I was all agog to contribute to ecological sciences in India. Despite good postdoc offers from reputed institutions outside India, I opted for the fellowship at the National Centre for Biological Sciences (NCBS) because I wanted to do my own science without relying on the resources and status of a Western team. Wishing to spend a couple of years immersed in research, a faculty job was not an immediate priority. Best-laid plans, however, were cut short by my 37th birthday. My unconventional trajectory into science meant that I was hovering close to the point where my job application would be rejected just because I was 'too old'. I was unaware of this until a chance conversation with a senior scientist!

Clearly, I did not have the luxury of savouring postdoc years devoted solely to research. Instead began a frenzied search for positions and convincing people that I am good enough for a faculty position even without the now mandated requirement of 3-4 years of postdoc experience. It helped that my publication record was reasonably good for my career stage, but I was competing against those who ticked this alongside other boxes. Doing a postdoc would render me too old for jobs. Without a postdoc, I don't qualify as competent enough. To add to it, not doing a postdoc abroad apparently cuts my value and shuts out grant opportunities. Call it a pickle or a stew, I was cooked.

I am not caught alone in the age-trap. Others have faced the same impasse for different reasons. The situation has prompted some senior academics to acknowledge that age and postdoc experience should not be the sole criteria for screening and what matters most is how well one can articulate their work and demonstrate a firm grasp of their chosen field. I have also heard it said that

the PhD itself should train one enough to start their lab; postdoctoral stints mainly build academic connections and ramp up the CV for publications. Of course, postdoc time also helps build and hone new skills, but this can and should happen at all career stages. Good intentions clearly abound, but we need that translated to systemic change.

Here's the thing. I understand that academic jobs are scarce in India. You need criteria that will help sort the large applicant pool, but should suitability for academia be defined by a narrow set of parameters related to age and postdoc stints at overseas institutions? Should science, collegiality, and mentoring capacity not be the main filters? One might argue that age and a diversity of experience can provide a more mature and holistic ability to run a lab and illustrious postdoc affiliations do not guarantee that you will do good science. Can an eclectic background, so long as it includes good science, not be an asset for research and teaching? Is there no space to recognize individual talents and potential to contribute to the institution on a case-by-case basis?

The situation reminds me of erstwhile tropes of women being 'too old' to find a life partner, for women had to fit a very narrow bill of suitability and function. As a society, we have moved in the right direction away from these arbitrary numeric impositions. Perhaps it is time that academia also reconsiders their basis for choosing their members. After all, human resources are the lifeline for science. People matter, not numbers.

There have been other challenges. Poor mentorship and a lack of concern for your well-being from some senior colleagues. Ecological science being classified as 'not real biology'—it appears that the study of life outside a lab or without experimental manipulation is somehow not life science. The question "how is any of this useful to us?"— a belief that only science that bears tangible application for human well-being is science "good enough". On the other hand, I have gained immensely from peers and senior colleagues alike, whose generosity, guidance, and support have helped me navigate the rocky road to academic reality. I am building newer life skills to better tackle the everyday challenges. Mostly, I make sure to keep a positive outlook.

I am now at Centre for Cellular and Molecular Biology (CCMB) where I am learning more about the biological sciences from a diverse array of colleagues. It is still early days, but I am excited to help grow a program in ecology and evolution at an institute that so far focused on the cellular and molecular. I will give this my best shot, refusing to succumb to the condescension that my age, unconventional path, or choice of field makes me somehow deficient. I am also assured by the fact that academia is not the end. I can find respect for my skills outside the academic world.

My love for science will not abate, but academia has much room to improve. Mainly, we need an openness to introspect on our policies and practice to build systems that offer a dynamic, respectful and equitable environment for a diverse set of ideas and individuals. To attract and retain talent, we should reflect on the breadth of our scientific vision, inculcate nuance in choosing members, develop systemic support for early-career scientists, and put in place measures to stem burnout and prevent disillusionment.

I sincerely hope that the right winds of change will soon sweep through our academic halls.

Meghna Krishnadas is a Project Scientist at the CSIR-Centre for Cellular and Molecular Biology (CCMB), Hyderabad.

A Whole New World

Finding an Academic Home in India

Karla P. Mercado-Shekhar

I was born in the Philippines and raised in Guam, an island territory of the United States. I became a United States (US) citizen as a child and made my way to the mainland for higher education. I obtained my Bachelor's degree at Boston University and PhD from the University of Rochester and was a Postdoctoral Fellow at the University of Cincinnati College of Medicine. My career trajectory was nothing unusual thus far. However, I then ventured on a road less travelled when I moved to India to pursue an academic career.

My decision to move to India was taken over several years. I met my future husband (Himanshu Shekhar) in graduate school and became aware of his desire to move back to India after his training to contribute to the research ecosystem in his home country. I was intrigued by his inclination because a majority of Indian graduate student colleagues in the US preferred to stay back. Himanshu was well-informed about the academic scenario in India but I wanted to find out more for myself about the possibility of moving to India and contributing to cutting-edge science.

I gradually familiarized myself with the culture, history, academic environment, research-funding scenario, and healthcare system of India.

I learned that despite its long-standing challenges, the Indian research ecosystem was developing rapidly, more institutions were being created, and the research productivity of existing institutions was on the rise. I was pleasantly surprised, but having spent my formative years in the US, I wanted to ensure that I could make India my home and potentially thrive as an academic researcher.

While we were postdoctoral fellows at the University of Cincinnati College of Medicine, Himanshu and I attended the Young Investigators' Meeting (YIM) in Boston, USA, in 2015. YIM provides a platform for early-career researchers for acquiring information about transitioning to an academic position in India. I interacted with faculty and administrators from leading Indian institutes and funding agencies, who gave a comprehensive overview of the current academic scenario. These discussions provided valuable insight into preparing for a faculty position and the expectations from new faculty.

The YIM mentors also shared the challenges that new faculty faced, such as setting up research infrastructure, acquiring instrumentation and reagents, attracting students, and balancing research, teaching, and service. I noted that these challenges were ubiquitous at institutions abroad. Thereafter, I took every opportunity to attend events to learn more about Indian academia.

I participated in another YIM event held in Chicago in 2016. Attending YIMs connected us to like-minded individuals who shared our vision of teaching and conducting scientific research in India. I also interacted with young faculty who had recently established their research in India and already had impressive accomplishments. These interactions greatly increased my confidence, and over the next several months, I travelled widely to interact with representatives from various Indian Institutes of Technology (IITs) and other leading institutions, such as at events held at the University of Chicago and Purdue University.

I visited India for the first time in 2017 when Himanshu and I got married in Kolkata. We decided to make use of this opportunity to informally explore future job opportunities. Four days after our wedding, we visited the Indian Institute of Technology Kharagpur to present seminars and witness Indian

academia firsthand. Overall, this visit was eye-opening for me. I was delighted to see that many of the labs were well-equipped, the faculty were motivated, and the students seemed bright. This experience assured me of the potential to succeed as an academic researcher in India. Moreover, interactions with individual faculty members provided me with an understanding of the expectations from prospective faculty.

Our next visit to India was two years later, after the birth of our daughter. During this trip, we interviewed at five institutions. It was exciting to interact with academics from all over India and to receive feedback on our research directions. Himanshu and I were also facing a dual-career situation, and we decided not to consider positions in different cities. After careful consideration, we joined the Indian Institute of Technology Gandhinagar (IITGN) – an institute that had impressed us by its interdisciplinary academic culture and student-friendly approach.

An important factor affecting my decision to move to India was my research focus. As a biomedical engineer, my prior work was focused on ultrasound, primarily in the American context. However, the healthcare challenges in India are starkly different from those in the US. Ultrasound is an affordable and widely accessible imaging modality and has immense potential for growth in India. I envision that working in India could also be gratifying because of the opportunity to train a large number of students who would assume leading positions in academia and industry.

I received the Overseas Citizen of India (OCI) status, a life-long visa for non-Indian citizens, which allowed me to hold a permanent position in India. My decision to move to India surprised many of my peers. However, my family and mentors supported my transition after realizing that I had taken this decision after a lot of thought and exploration.

My experience at IITGN has been fruitful since I joined in April 2019. I taught two new courses that were received well and obtained initial funding support and space to set up my laboratory and hire a postdoctoral fellow. I am currently working with a postdoc, a PhD student, and 2 MTech students who are helping develop my research program. Moreover, I received funds to

purchase a major piece of equipment through a competitive internal research proposal. Because of my OCI status, my external grant applications required me to have an Indian co-principal investigator, which I did not consider a problem because of the interdisciplinary nature of my research.

The inclusive culture of IITGN helped me transition to my new home. My colleagues have been supportive of my work and have helped me navigate hurdles. Although a majority of individuals at IITGN speak English, language can sometimes be a barrier when talking to staff, vendors, and officials. However, I am taking measures to improve my Hindi. Official procedures are also quite different in India, but I have been able to reach out to my colleagues who are always available to help.

Building a lab, acquiring equipment, forming a research group, teaching new courses, and service-related duties can sometimes be overwhelming for a new faculty. However, my friends who are early-career faculty at institutions abroad. have confided in me that they are also facing similar issues. The realization that these issues are not specific to India has helped me maintain a positive outlook when faced with such challenges.

We learn from the experiences we have and the people we meet. Additionally, interacting with peers at IITGN has helped me develop new ideas, beyond my immediate research plans. Therefore, instead of taking a rigid stance, I have found it helpful to allow my plans to evolve based on the infrastructure and expertise available in my ecosystem.

Although moving to India was a huge step, I never doubted that I will be able to adjust here and pursue a satisfying career. The last 10 months have been an exciting adventure beyond my expectations. I have learned that finding our path in life is akin to research. When we venture on the road less travelled, we are more likely to experience the joy of discovery.

Karla P. Mercado-Shekhar is an Assistant Professor in the Department of Biological Engineering, Indian Institute of Technology (IIT) Gandhinagar.

It's Never too Late to Get Back to Science

Ujjaini Dasgupta

To be a scientist and run an independent research group has been a dream that I have nurtured since my PhD days. I joined as an Assistant Professor at Amity Institute of Integrative Sciences and Health, Amity University Haryana in 2016 where my group (Laboratory of Sphingolipid Biology) is working on decoding the intricacies of sphingolipid signalling during tumour progression using multidisciplinary approaches.

The Amity Institute of Integrative Sciences and Health (AIISH) is a new initiative of Amity University, Haryana, designed to perform interdisciplinary research at the interface of innovative advances in molecular medicine and healthcare and is headed by Rajendra Prasad, an eminent Indian molecular mycologist.

When I was in school, I did not think much about a career except wanting to follow my older cousins who were successful physicists. I completed my BSc (Hons.) from Presidency College, Calcutta (now Presidency University). I still have very fond memories of my esteemed college and this was the place that invoked my interest in biological sciences for the first time.

I then completed my MSc in Biophysics and Molecular Biology from the

Department of Biophysics and Molecular Biology, University of Calcutta. During my MSc, I was trained by some of the best teachers I can think of, who sowed the seeds of research in my young mind.

My MSc days also taught me to never to give up on a problem. This is a driving force that has guided me throughout my scientific career. While pursuing a PhD at Delhi University (South Campus), my serious liking for the field of signal transduction grew, starting with intricacies of light signal transduction and photomorphogenic mutants of Arabidopsis who can see "light in darkness".

I started my postdoctoral work at the University of Massachusetts, Medical School doing an elaborate screen designed to identify novel components of the Hedgehog signalling pathway using Drosophila as a model system. In spite of my mentor's and my undeterred dedication and sincere efforts, the screen did not work due to some technical problems. Even though I had invested more than a year on this screen right at the beginning of a postdoctoral career, I did not take this as a setback and immediately started another screen that eventually ended with a publication in PNAS. By the end of my postdoctoral research, my interest in lipids as signalling molecules in disease models had taken a concrete shape.

After my postdoctoral research, I moved away from academic research and pursued a career in scientific administration and infrastructure support development. I worked initially on a collaborative project with Labindia Lifesciences Pvt. Ltd. and Delhi University and later at Advanced Technology Platform Center at the Regional Centre for Biotechnology (RCB), Faridabad. I gained substantial experience and a wide perspective of both academic research (through graduate and postdoctoral research experience) and non-academic managerial skills, which helped me evaluate the depth and feasibility of research questions.

Though I moved away from doing active science, I kept myself updated with contemporary research in my field. During this period, while enjoying many invaluable and invigorating scientific discussions with faculty friends in the community, I realized that my passion actually lies in pursuing mainstream

science. Although I had lost some time after my postdoctoral research, I felt that it is never too late and decided to make a comeback into science after six years. Support from the family and some friends in the scientific community made me feel confident about the decision.

It was not an easy task as I left my comfort zone and was competing with postdocs with fresh publications, while I had had none in the past five years. I came to know that Amity University Haryana had just opened a research wing led by Rajendra Prasad. Though I did not know him at the time, I had heard from some of my friends that he is a true visionary. After my first meeting with him, I became convinced that if I am to be given a second chance to pursue my scientific career then this will be one of the best opportunities to avail. His vision, passion, and enthusiasm for science had no bounds and soon I joined Amity University Haryana as an Assistant Professor. One of my major considerations for joining AIISH was his vision to establish the Center for Lipidomics that would enable me and other researchers do cutting-edge research in lipid biology.

The next year went by in a whirlwind with some teaching responsibilities and writing grants. Many of them got rejected, but some got accepted (to my relief). After obtaining a couple of grants, I started the journey of building a career in academia, block by block—getting the lab running, getting instruments, guiding students, finally doing the first experiment, followed by the first publication.

My previous experience in developing platform technologies gave me insight into setting up and smooth running of infrastructural and instrumentation facilities at Amity University. It becomes very tough for the scientific community to accept you as a serious scientist if you have a six-year gap in your research experience, and this made me more determined and hard-working.

Support from colleagues at Amity University, friends from the academic circle, and family helped me establish an active research group working on challenging problems in cancer biology in the Indian context. As getting publications matters the most for a new scientist, my first publication gave

me the much-needed confidence to go forward and work harder.

I truly believe that the following few golden rules helped me to get the best from my journey till now.

- *Grab every opportunity as it comes:* When I started looking for an academic position, my choices were limited. There were a lot of questions since I was joining a private university where teaching was a primary mandate. Keeping in mind the pros and cons, I believed in the vision of Rajendra Prasad, who led the research wing I joined. So, the right opportunities at the right time should be recognized and availed even if the path to them is challenging.

- *Take one step at a time before you fly high:* When the situation is not perfect and there is a research gap of several years, then the best way to get going is to take one small step at a time and go for the next step with renewed vigour. Everything is not always as perfect as it should be, and everything does not always work in your favour. Knowing the limitations, I never restricted myself to big grants. I applied for whatever came my way, knowing that I had to start somewhere and then go for more. Even the success of the simplest of experiments in my lab gives me happiness and confidence.

- *There is no shortcut to success:* Success is a relative term; every individual sets his/her own limits that define success for him/her. However, there is no shortcut to success at any time. Your passion will never fail you if you combine it with generous portions of willpower, strength of mind, hard work and confidence.

- *Importance of good collaborations:* The impact of good collaborations is far-reaching and rewarding. For young scientists like us, it is an absolute must as it widens the horizon of science and gives us an opportunity for interactions, complementation, cohesion and opportunities to do multidisciplinary science.

At the end of the day, I am happy that I can pursue my passion. Private

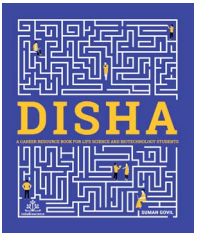
universities in India are building strong infrastructure along with support from the Government of India and are providing a fantastic atmosphere to do good science. It is the urge to satisfy your scientific craving that keeps you going and it is never too late to do it.

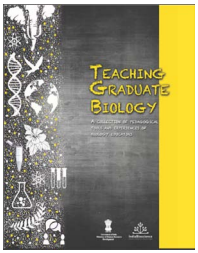
Ujjaini Dasgupta is an Assistant Professor at Amity Institute of Integrative Sciences and Health, Amity University, Haryana.

Our Other Publications

Spoorthi is an eBooklet featuring resources for women in science in India, in addition to articles born out of conversations with several such trailblazing women. You can download it at ***http://bit.ly/Spoorthi***

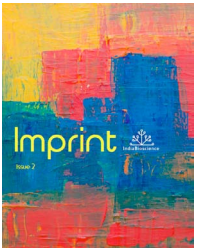
Disha is a comprehensive resource meant to help life science and biotechnology students in India navigate their careers in science. In addition to providing information about various careeer paths, the book also provides tips on progessional development.





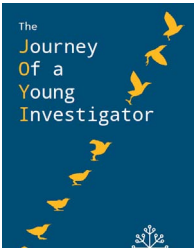
Teaching Graduate Biology is a compendium of our popular articles on the topic of higher education. The collection showcases techniques biology teachers use in their classrooms, and their teaching experiences. Download the book here - ***http://bit.ly/TeachingGraduate***

Imprint showcases the the diversity of articles published on indiabioscience.org, by collecting some of our most popular news and column stories in one place. You can download it here - ***http://bit.ly/ImprintIssue1*** (Issue 1) and ***http://bit.ly/Imprint2*** (Issue 2)



This concise e-booklet introduces a whole range of career options available to students of science in India. Download it here - ***http://bit.ly/ScienceCar***

We asked young investigators attending YIM 2019 to share their scientific journeys with us. This collection celebrates those successes. Download it here - ***http://bit.ly/joyi2019***



Alumni from the first ten years of YIM returned to discuss the future of Indian science during YIM 2018. Here are some of their stories - ***http://bit.ly/joyi2018***

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About us

IndiaBioscience is an organization that fills a unique niche in the ecosystem of the life sciences in India, by being a catalyst to promote changes that affect the culture and practice of the field, through engagement with academia, government and industry at various levels. IndiaBioscience aims to increase the visibility of science in society, by being a hub for policy discussions, science communication, and as an aggregator of information.

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