PET and, together with the company Carbios at Clermont-Ferrand, has developed a recycling process that can use PET bottles and clothing with polyester fabrics as feedstock. In both cases, the process doesn't depend on the purity of the material, as it produces monomers that can be readily separated from any residues left.

Recycling efforts are often hampered by the use of different materials in combination, such as plastic coatings or impregnations meant to protect the underlying fabric. Thus, textiles and fishing nets are often impregnated with polyurethanes like Impranil, which make recycling difficult.

Known enzymes like LCC cut down urethane chains by dissolving the ester bonds, but they leave the characteristic carbamate bonds of urethanes intact. The groups of Nick Wierckx at the Research Centre Jülich and Karl-Erich Jaeger at the University of Düsseldorf, Germany have recently characterised a bacterial strain that can completely digest coatings like Impranil and can even use them as its only carbon source (Microb. Biotechnol. (2024) *17*, e14362). The bacterium *Halopseudomonas formosensis* was originally isolated from a compost heap and is heat tolerant up to 50°C. Its genus is so little known that the teams had to start by developing the molecular biology tools to be able to carry out genetic manipulations on this strain (Microb. Biotechnol. (2024) *17*, e14369). They hope to be able to develop biotechnological processes to make the recycling of composite synthetic materials possible.

Nylon is another persistent cause of problems. Although best known for its use in synthetic stockings, it also serves in vast fishing nets that can weigh tonnes and are often discarded at sea when they reach the end of their useful lifetime. These nets are typically made from nylon 6 (also known as Perlon in the textile industry), a polymer that is made from one type of monomer rather than a combination of two — a subtle change in the recipe invented for the sole purpose of patent avoidance.

Nylon 6 is widely regarded as non-biodegradable, even though it is held together by amide bonds not fundamentally different from those in proteins and peptides. Its resistance may be due to the dense network of hydrogen bonds holding the chains together and making access difficult for enzymes. The group of Tobin Marks at Northwestern University in Evanston, USA has developed an inorganic catalyst that can cut nylon 6 down to its caprolactam monomers, which can easily be separated from unprocessed residue and can be recycled to produce fresh nylon (Chem (2024) *10*, 172–189).

Ban microplastics

It may be a major challenge to stop the inadvertent production and release of so-called secondary microplastics, such as particles rubbed off from tyres, carpets, clothes and many other everyday items. Primary microplastics are much easier to address as these are intentionally produced and often applied in situations where their release into the environment is to be expected. These include plastic glitter, exfoliating cosmetic products and others.

As part of its European Green Deal, the EU has amended the REACH (Registration, Evaluation, Authorisation and Restriction of Chemicals) regulation to phase out the use of intentionally produced microplastics in products that may release them into the environment. The new law came into force in October 2023 but is spreading the ban in phases over 12 years. Thus, loose glitter is already banned, but rinse-off cosmetics with microplastics will only be affected in 2027. Further partial bans will take effect between 2028 and 2035.

While undoubtedly necessary and overdue, these bans only address a part of the global plastic pollution problem that we are facing. As the ongoing UNEP process is highlighting, a stop to plastic pollution will require global cooperation and a willingness to change our ways. Both resources are currently sparse if climate inaction is any guide, but one should still hope that the UN can come up with a meaningful treaty at the end of this year.

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Q & A

Mubarak Hussain Syed

Syed, Mubarak Hussain (Syed), nickname 'FlyGuy', is an Assistant Professor in the Biology Department at the University of New Mexico (UNM) in Albuquerque, New Mexico. Syed grew up in a small village in Kashmir and was an undergraduate at Amar Singh College, Srinagar, and then a Master's student in the Biochemistry Department at the University of Kashmir. After a short spell of teaching at Women's Polytechnic College Srinagar, he moved to Bengaluru, where he started working as a Junior Research Fellow with the late Veronica Rodriguez at the National Center for Biological Sciences. He received an International Max Planck PhD fellowship to work on glial development and function with Christian Klaembt at the University of Muenster. Then, he did a postdoc with Chris Doe at the University of Oregon, where he studied the temporal patterning of neural progenitors. In 2019, he started his independent research group at UNM, where he and his collaborators study the developmental mechanisms regulating neural diversity, circuit assembly, and behavior. He has invested heavily in providing access for marginalized communities to science and education through JKScientists and Pueblo Brain Science – Building Diversity in Neuroscience, which he founded to promote science globally.

What turned you on to biology in the first place? While growing up in a remote village in the conflict-ridden vale of Kashmir, I was fortunate to have access to and explore the rich biodiversity in our backyard and neighborhood. Back then, our educational institutions were resource limited (and probably still are), and we rarely got a chance to perform hands-on experiments, even in college or university. Unfortunately, the enduring conflict that has plagued Kashmir since the late 1980s has taken a severe toll on education, more specifically during our generation when it all started. The educational institutions were closed frequently for extended periods, and we had to rely heavily on homeschooling while surviving each passing day. Observing all the amazing creatures in my village inspired my interest in biology,

and two amazing teachers, Wilayat Rizvi and Khursheed Andrabi, reinforced that interest. Unfortunately, due to political unrest, modernization, and global warming, biodiversity in Kashmir has been declining over the past decades.

Could you tell us more about your research journey, your key early influences, and your mentors? Both my parents had not taken any formal education, and I was the first in the family to earn a PhD. My elder brother and my uncles greatly influenced my early education and supported me in pursuing my ambitions. It was extremely difficult for our generation, who grew up during the political turmoil in Kashmir. After finishing my MS in Biochemistry from the University of Kashmir, I worked as a teacher for a few months in Kashmir, but soon realized I needed to explore and learn more before returning to this noble profession. It was hard, however, to convince my family that I needed to leave Kashmir and start the journey of exploration full of struggles, adventure, and exciting moments. I decided to move to Bengaluru, an adventurous 3-day journey by road and train combined. There, I stayed close to the National Biological Science (NCBS) — one of the leading research institutions. Even as an outsider, I would visit NCBS daily and share tea/lunch with scientists working on diverse topics. After four months of struggle, I was excited to see a poster advertising the two-week free 'Developmental Biology Workshop' organized by Benny Shilo. This workshop provided my first exposure to science and a unique opportunity to meet and interact with eminent national and international scientists. This course allowed us to observe diverse model systems for solving developmental biology questions. I was fascinated to see neurons glowing under the microscope for the first time. No doubt, this workshop ignited my enthusiasm to examine the mysteries of brain development, which I am still exploring in my independent research group.

During this workshop, I met a leading neuroscientist, the late Veronica Rodriguez, who allowed me to volunteer in her lab at the NCBS. We shared lab space with Vijay Raghavan's lab and had an amazing time doing science and playing cricket. The early training and mentorship from Veronica and Vijay have been very impactful. At NCBS, I also met Ron Vale, who was on a sabbatical then and has been an informal mentor ever since. Besides doing cool science, Ron has invested heavily in efforts to diversify science. He has inspired many, including me, to promote science and education in underserved and resource-limited communities. I also met Shashidhara, and both Shasi and Vijay have strongly advocated for me and my activities to promote science in Kashmir.

I got a place on the International Max Planck PhD program and moved to Germany for my PhD, where I got to work with another amazing mentor, Christian Klaembt. I discussed science, music, and culture with Herman Aberle, a junior faculty member at the same institution, and these conversations helped a lot in keeping me sane and finishing my PhD. For my postdoc, I decided to join Chris Doe, who I met at the Okinawa Developmental Neuroscience workshop. Chris has been a life-changing mentor for me: it was hard to leave his lab in Oregon and start my own research group at UNM in 2019. During this postdoc, I met Claude Desplan and Richard Mann; both are amazing scientists and great mentors. Claude has mentored many scientists, including many beyond his lab boundaries, and I was fortunate to be one of them.

The most challenging period was the initial few years of my faculty position, and COVID made it even more challenging — but again, I consider myself lucky to be in a supportive department and to have met my collaborators Katherine Nagel and Matthew Kayser, who have helped me navigate the early years of faculty life. My life and science partner, Qussin Joo, helped establish the lab while I was teaching and writing grants. My first two graduate students, Adil Wani and Aisha Hamid, and other current and past lab members, including Gonzalo M. Chaya, have worked hard and have done tremendously well, and they are also the main factor in my success as a faculty member. Last summer, we started a visiting scientist project with Vivek Jayaraman at Janelia Research Campus, a program that has opened up new learning opportunities for us.

Tell us more about your efforts to promote science and education globally. One of the major barriers to diversifying science is the unequal distribution of resources and opportunities in education and research. The developing parts of the world and places affected by political unrest and war lack infrastructure, resources, and opportunities to pursue science. Surprisingly, even within developed countries such as the USA, disparities in resource distribution are often stark, with marginalized communities bearing the brunt of systemic discrimination and exclusion. These communities face challenges in entering and staying in the scientific enterprise that exists today. My research, training, and mentoring programs have provided opportunities and mentorship to students and trainees from such communities for over a decade. My mission to diversify science globally is expanding and has an impact, thanks to many amazing people who share the same interests and have joined the movement.

During my PhD, I started thinking deeply about ways to reach out and help students back home. Whenever I got a chance I visited the University and colleges of Kashmir to interact with the students, discuss my science, and highlight various research and career opportunities.

My interest in helping and mentoring students grew exponentially after observing students' enthusiasm during my seminars and outreach sessions. I wanted to stay in touch with the students of that region and provide a virtual platform for interactions and discussions about science. In 2011, using Facebook, I started a closed

mentoring and networking group called JKScientists (Jammu and Kashmir Scientists; www.jkscientists.org); over the years, this group has gained momentum and currently has over 13,000 members. JKScientists is a non-profit organization and provides mentorship, skills development, and science outreach programs. In 2015, we organized an insect neuroscience workshop in Kashmir, where students enjoyed hands-on activities. This workshop was highly impactful and inspirational to many young students.

In Oregon, as a postdoc, I overlapped with then-graduate student Matthew Q. Clark, now a faculty at Bucknell University. Together, we organized many events in and outside of Chris's lab to reach out to the communities that have traditionally been neglected. We organized lab tours and visited classrooms in resource-limited schools close to Eugene, Oregon.

Can you tell us more about Pueblo Brain Science? After starting my new position at UNM, I realized the need to establish a science outreach and training program for the local students. UNM is a minority-serving institution and the only research-intensive university in New Mexico. Most of our students come from non-traditional, disadvantaged, and marginalized backgrounds. The education system ranks one of the lowest in the nation; public schools lack resources, and the opportunities to participate in research are scarce. Communities, such as the Native Americans, that have been historically marginalized and neglected do not have enough resources to invest in exposing students to science early in their educational institutions. I started an initiative, Pueblo Brain Science – Building Diversity in Neuroscience (www.pueblobrainscience.org), which aims to foster science and education among underrepresented and marginalized communities, including the Pueblos of Zia and Jemez. Pueblo Brain Science has various programs: NeuroCURE, Neuroscience Workshop, Meet A Scientist, NEURONAL, and Science Outreach. Various volunteers also run some of these programs and target students and trainees at various career levels. NeuroCURE is a discovery-based course where 12–14 undergrads with no or little research experience embark on the journey of science and learn how to be a scientist (https://www.pueblobrainscience.org/). Each spring, together with Matthew Clark, who shares similar interests, we organize a three-day neuroscience workshop for the students and teachers of New Mexico. NEURONAL is an informal mentoring program led by Jessica Belmares-Ortega and Ethan Wilson. Through the Meet A Scientist program, over 25 neuroscientists of diverse backgrounds have interacted with our students. This program started during the pandemic, with Chris Doe and Alex Kolodkin being the first volunteers, and is now operating in person.

Last year, I had a desire to assemble all the cool scientists who have an interest in the development of lineages, circuits, and behavior in New Mexico. My wish came true when Kathy Nagel, David Schoppik, and Josie Clowney joined to co-organize and support a two-day 'Specification of Complex Behaviors' symposium at UNM. An amazing group of scientists who are leaders in the field volunteered their time and resources to make this event happen. All these scientists are part of the Pueblo Brain Science initiative; over the years, we envision it as a sustainable program with transformational outcomes in promoting diversity in science. The communities of the Pueblos of Zia and Jemez invite us to their native festivals, youth festivals, and education retreats; we feel part of the family.

Fruit flies are an excellent model system for doing science and science-related activities in resource-limited places. Andreas Prokop and the fly community have generated useful resources for our research and education-related activities. The open-source, 3D-printed tools for assaying behaviors, such as PiVR and Ethoscope, have helped us convey our excitement and knowledge of neuroscience to high-school students in various schools across New Mexico. These students love to build and use these tools under the supervision of our tech guru, Krishna Patel. We have visited many schools in New Mexico and always bring fruit flies and PiVR to the classrooms — school kids have started calling me the 'FlyGuy'.

Through these activities, we will train and mentor these young scientists, but retaining them in science is another challenge that needs to be addressed.

Can you tell us more about the neuroscience workshop? This three-day event at the UNM is more like a summer camp, where high-school students, teachers, undergrads, and graduate students come together to learn and perform hands-on, neuroscience-related activities. The first workshop started in the spring of 2022 and was generously funded by the Grass Foundation. Since then we have grown, and many faculty from outside New Mexico participate as instructors. Last year, we managed without funds, thanks to the instructors who paid for their own travel and the local business that sponsored our food. In 2023, the COVID restrictions were over, and we were excited to see the students from the Pueblo of Zia participate and share their excitement about seeking knowledge and learning new skills. We had undergrads from San Juan Community College join us as well. In addition to three days of hands-on activities, we had a 'Being a Native Scientist: Challenges and Opportunities' session, where Macaiah Shendo and Ethan Wilson shared their experience of living on the Reservations and their journey into science. The workshop concluded with a keynote speech by Veronica Evans, a San Juan Community College faculty member passionate about providing opportunities to her students and mentees.

The Howard Hughes Medical Institute will fully fund this year's workshop, and we are excited to expand it to the San Juan College in Farmington, where many more faculty members from various institutions will join the initiative.

What are the various challenges scholars and scientists face in disadvantaged and resource-limited places? Doing cutting-edge science requires funds, infrastructure, and access to resources; our educational institutions in Kashmir lack infrastructure, and opportunities for the trainees to grow are limited.

Getting access to scientific papers was challenging as a student; maybe things have changed since then — scientific findings should be accessible to all, and only then will equity and equality prevail. Many scientists and scholars lose months of work when labs are closed due to political unrest, and it has happened many times — most recently in the fall of 2019 when communication was

blocked in Kashmir for over five months. All the educational institutions were shut and locked; only the *Scientist* magazine highlighted the struggle of scientists, and the main journals didn't bother to talk about it, neither did the National Academy of Sciences.

In the summer of 2016, I organized an international conference, 'Stem Cells to Neural Circuits', in Kashmir with many of my mentors, including Chris Doe, Richard Mann, and colleagues from the USA, Germany, and India flying there at their own expense to make this event happen. Everything was set; unfortunately, just a few days before the conference, the day I landed at Srinagar airport, there was huge civil unrest, and all of Kashmir was under curfew for over a month. Communication was blocked, and I couldn't communicate with any of the invited speakers, some of whom had already started their journey. Someday, I hope to organize this event again in Kashmir.

After relocating to beautiful New Mexico, The Land of Enchantment, and visiting the Pueblos, I realized that, even within the USA, some places lack resources and infrastructure, and unfortunately the Real Americans (Indigenous people) are forced to live on Reservations where they don't have access to modern-day science and technology. Despite limitations in resources and opportunities, students will excel in any field if given the opportunity, training, and proper mentoring.

What advice would you give to students? We all need mentors, especially if you are a first-generation student or a student from an underprivileged background. Reach out and find supportive mentors and network. Start asking questions, be proactive, and visit professor office hours. Your professors are humans like you and are happy to answer your scientific or career-related questions — take advantage of the resources around you.

What is it like to be a global scientist? In addition to doing science, which is exciting but can sometimes be stressful, international students and trainees have to deal with many other issues related to being away from family, visas, and other unfortunate events such as war. In Germany, it was hard to integrate into the system, which I thought was due to the language barrier; Google Translate was not advanced then! I tried to learn German for a year, and when the grammar part became difficult, and the experiments needed more attention, I gave up. Getting a US visa on time was always an issue. Even when I started working as a postdoc or as a faculty member, my mentors and the university had to write letters to the embassy to support me with getting a visa on time, a process that was always subject to background checks. In the US, international scientists also need letters of support for their Green Card application. I am thankful to all the amazing global scientists who have written letters of support for my application; you are doing a great service to promote diversity in science. I have heard stories of many international students and postdocs being abused by PIs. In the US, international graduate students are not eligible to apply for fellowships. For international postdocs, finding a job in biotech is more challenging since it requires a work visa sponsorship from the industry, and there are limited quotas. If English is your second language, as it is for me, writing anything, including papers and grants, takes extra time.

What are your thoughts on ways to make science more inclusive? Various DEIA initiatives have been started, and many institutions and societies are progressing well, but much needs to be done. When we say that all are equal or all lives matter, we should mean it. I am happy to see scientists opening labs and societies making special programs for scientists affected by war. If all lives matter, why not make such efforts for the scientists in other war-affected regions — Kashmir, African countries, the Middle East, and many others?

Resources must be distributed equally; it seems the rich are getting richer, and the universities in small places struggle. At conferences, we need to be mindful when interacting with faculty or students who are not from famous or so-called prestigious institutions — be kind and show respect. The environment and atmosphere in social and networking sessions at the conferences and institutions should be welcoming to trainees from all backgrounds and identities. Invite faculty from diverse backgrounds and geographically diverse and minority-serving institutions as conference speakers and workshop instructors; they have first-hand experience training and mentoring students from marginalized and historically excluded communities. It seems that scientific contributions are narrowly assessed based on how many papers one publishes; efforts to educate and mentor students must also be recognized and valued in assessing scientific contributions. It is good to see some private and federal agencies, including NSF and NIH, starting programs to support such faculty.

Mentees from diverse backgrounds follow diverse traditions and religious beliefs: acknowledging and accommodating their needs is essential for the academic success of trainees. Some trainees like to pray or meditate; helping them find a quiet space to practice their faith and rituals is also very important.

What are your greatest research and training ambitions? To contribute to the understanding of how developmental cues shape circuit structure and function in the fruit fly brain and to promote diversity in science by training a diverse force of next-generation scientists.

How do you manage the stress associated with the job? Playing group sports, running, hiking, spending time with loved ones, and helping people greatly helps. In Oregon, during my postdoc, I used to play cricket, run, and hike. I continue running and hiking in New Mexico with my two little sons. Someday, I will return to cricket. From Kashmir to New Mexico, I try to help as many students as possible, which helps me stay happy.

Were you a bowler or a batsman? Haha… Once at Kashmir University, I scored 23 runs in the last over, and in Oregon, I took six wickets, you decide! Vivek has yet to face my pace.

Do you feel a push toward more applied science? How does that affect your work? I feel both basic and applied sciences are important, and most often, down the road, basic science finds application, and we get mRNA vaccines and CRISPR–Cas9. To fix a machine, we need first to figure out the parts of the machine and how they are assembled —

the same principles apply to fixing brain diseases and disorders. Unfortunately, limited funding and many agencies, including federal agencies pushing for more translational science, put lots of pressure, especially on the junior faculty. I felt the pressure, but I was lucky to get the National Science Foundation CAREER award, which was a huge relief, and allows us to keep investigating fundamental principles regulating neural diversity.

Have you ever thought of going back to Kashmir? Staying away from family, friends, and the community is hard. During our conversations, my late grandmother used to ask me why I was leaving for Germany to work on flies when there are so many flies here in our neighborhood, and she asked the same question when I moved to the USA. I still have no clear answer except that I can contribute more to science globally with the resources and opportunities here. I have stayed in touch and contributed in my capacity to science and education in Kashmir through JKScientsts. I love to visit, meet my family and students there, and backpack if the situation is normal.

Any concluding remarks? There is a Chinese proverb: "a journey of a thousand miles begins with a single step". My scientific journey from the East to the West would have been impossible without the opportunities, training, and mentoring I received. I am grateful to all, especially my mentors, who have been part of this journey. Thanks to the funding agencies for funding our research and training programs; your support is making a huge impact on science and diversity in science. Together, we are building a supportive community of global scientists, and I am hopeful that someday we will all be global citizens in a world where all lives matter and are valued. If you want to be part of our programs or activities or want to visit Kashmir or New Mexico, which I highly recommend, please reach out. The journey continues…

DECLARATION OF INTERESTS

The author declares no competing interests.

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Quick guide

Nyctinasty

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What is nyctinasty? Some plants open their leaves during the day and close them at night, in a manner reminiscent of animal sleep. This circadian rhythmic behavior, termed nyctinasty, is regulated by a biological clock (Figure 1A). Nyctinasty has been observed in over 200 plant genera across 38 families, and is most frequently observed in legumes. People have long been fascinated by this intriguing behavior of plant leaves. The earliest record of nyctinasty dates back to Alexander the Great, whose admiral Androsthenes of Thasos described the nyctinasty of *Tamarindus indica* in 325 BC. Approximately 2000 years later, in 1729, the French astronomer Jean-Jacques d'Ortous de Mairan reported that the nyctinastic movement of *Mimosa pudica* continued even under conditions of continuous darkness — this is often cited as the first discovery of a biological clock. In the 19th century, Charles Darwin, who was famous for his theory of evolution, conducted many observations of plant movements, including nyctinasty, and established a scientific basis for the field.

How does nyctinasty occur? Intensive work by Ruth L. Satter and her colleagues in the late 20th century using a large legume, *Samanea saman* (Figure 1A), has contributed significantly to our understanding of the physiological mechanism of nyctinasty. Nyctinastic leaf movements are caused by changes in volume in two types of motor cells located on opposite sides of the pulvinus, a specialized motor organ located at the base of the leaf (Figure 1B). The pulvinus acts as a joint to change the position of the leaf. It is composed of, in order from the outside, the epidermis, the cortical tissue containing the motor cells, and the vascular tissue present in the center.

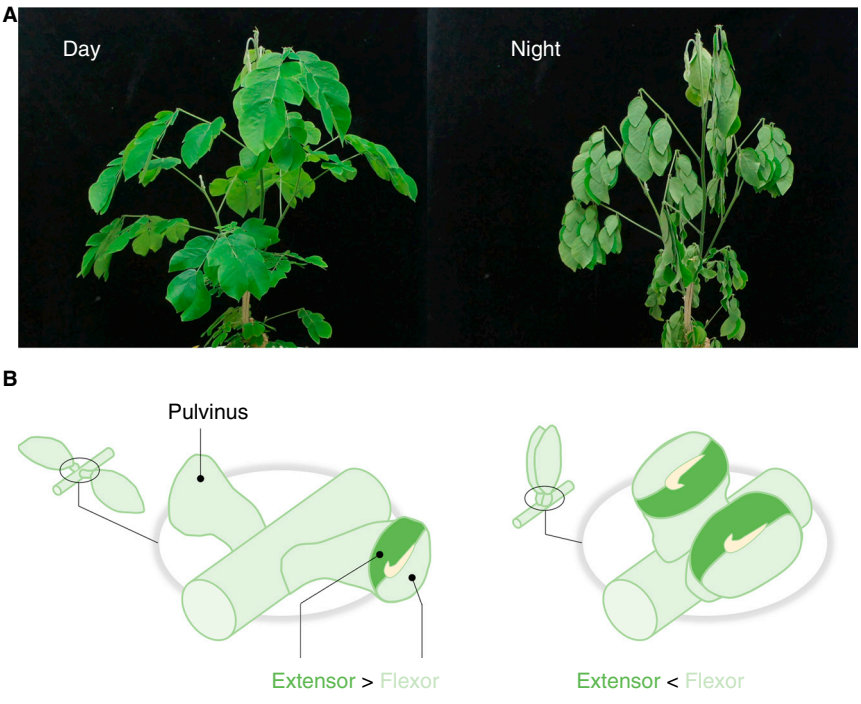

Figure 1. Nyctinastic leaf movement of *Samanea saman*.
(A) *S. saman* folds its leaves at night. (B) Leaf movement in *S. saman* is driven by asymmetric volume changes between the two types of motor cells in the pulvinus.