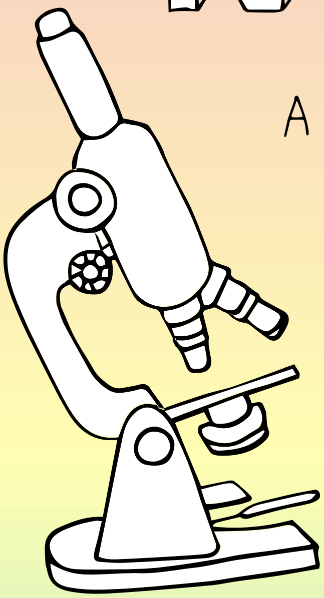
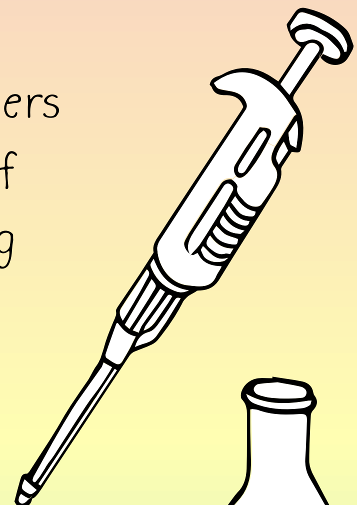
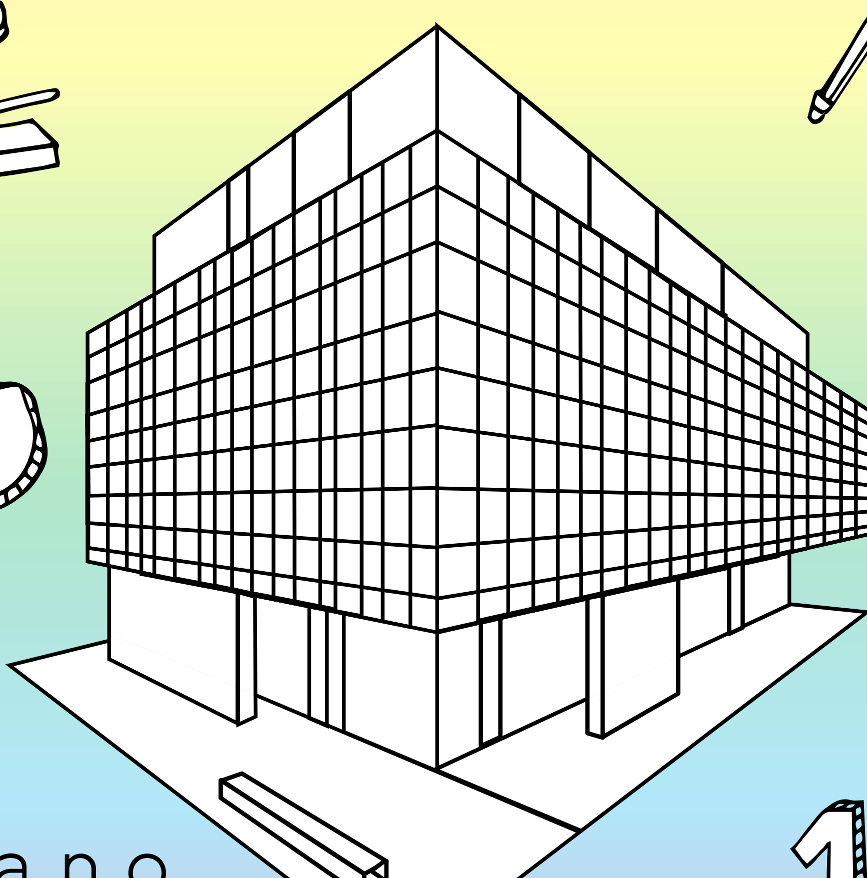
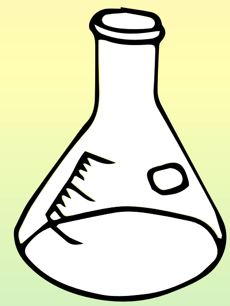
Explorers of the Nano Age

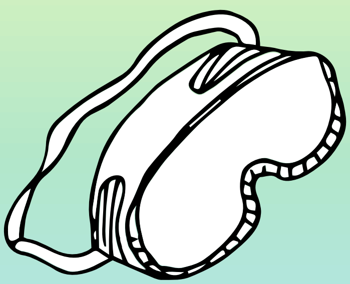


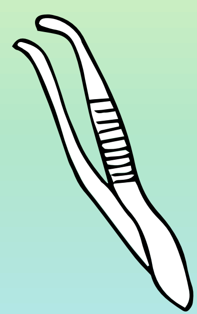


A coloring book celebrating researchers at MIT who are using the tools of nanoscale science and engineering to invent the world of tomorrow, one nanometer at a time.









From

MIT.nano

MIT's open-access facility for nanoscience and nanoengineering

10^{-9}

Printed in celebration of Nano Day 2022 Oct. 9,th 2022

Celebrating Nano Day

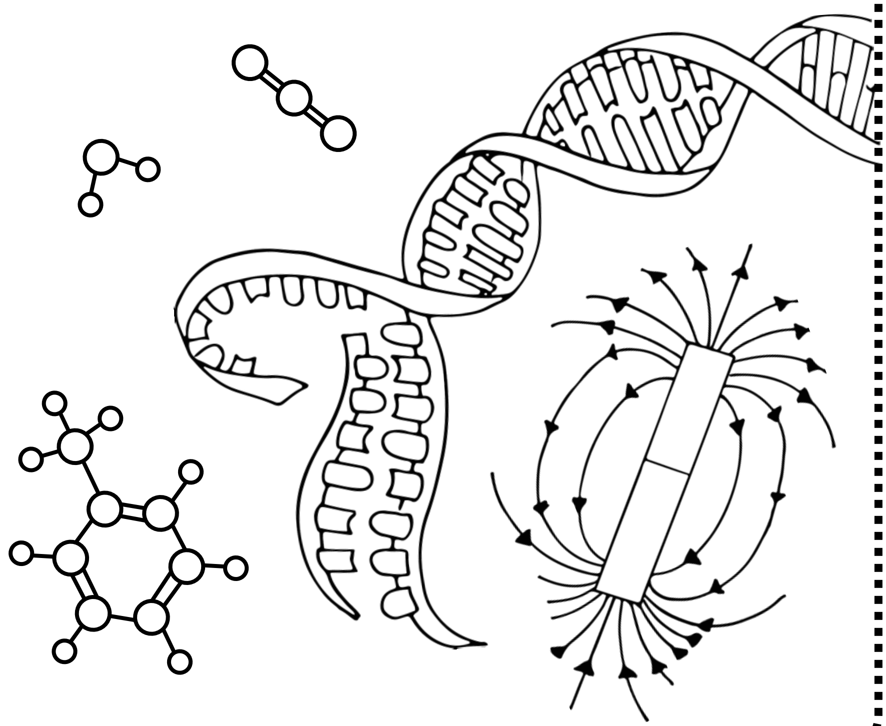
National Nanotechnology Day takes place every year on October 9—or 10/9. Why this date? Because a nanometer is one billionth of a meter, written as 0.000000001 or 1×10^{-9}.

Nano Day celebrates the world at the scale of nanometers and the incredible ability of nanoscientists and engineers to make discoveries and innovations that will help solve some of the biggest challenges facing society today. For Nano Day 2022, MIT.nano produced this coloring book for people of all ages and levels of expertise to learn about MIT scientists and engineers working to make our world a better place, starting at the nanoscale.

The world is at the dawn of the Nano Age.

MIT.nano is the center for nanoscience and nanoengineering at the Massachusetts Institute of Technology. Our laboratories are used by researchers, including the ones in this book, from nearly every department on campus. These pioneers are exploring solutions to challenges in health, climate, and energy; and discovering new possibilities in computing, communications, materials, manufacturing, and more—all through the power of nanotechnology.

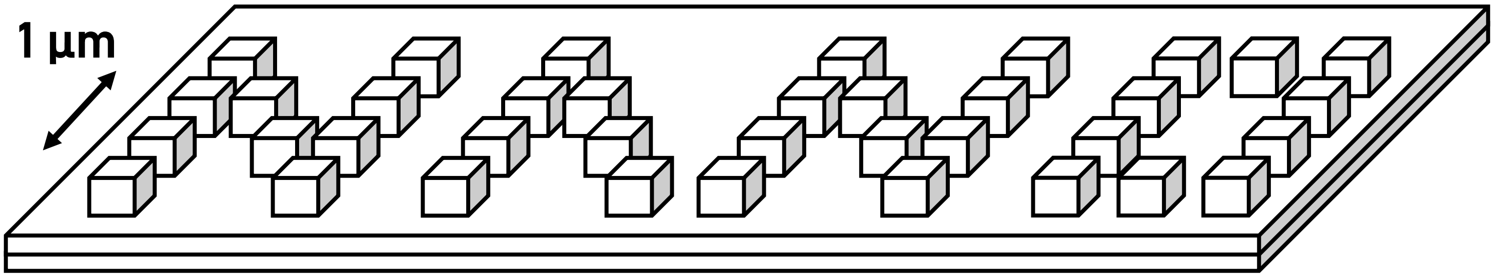
Learn more at mitnano.mit.edu.



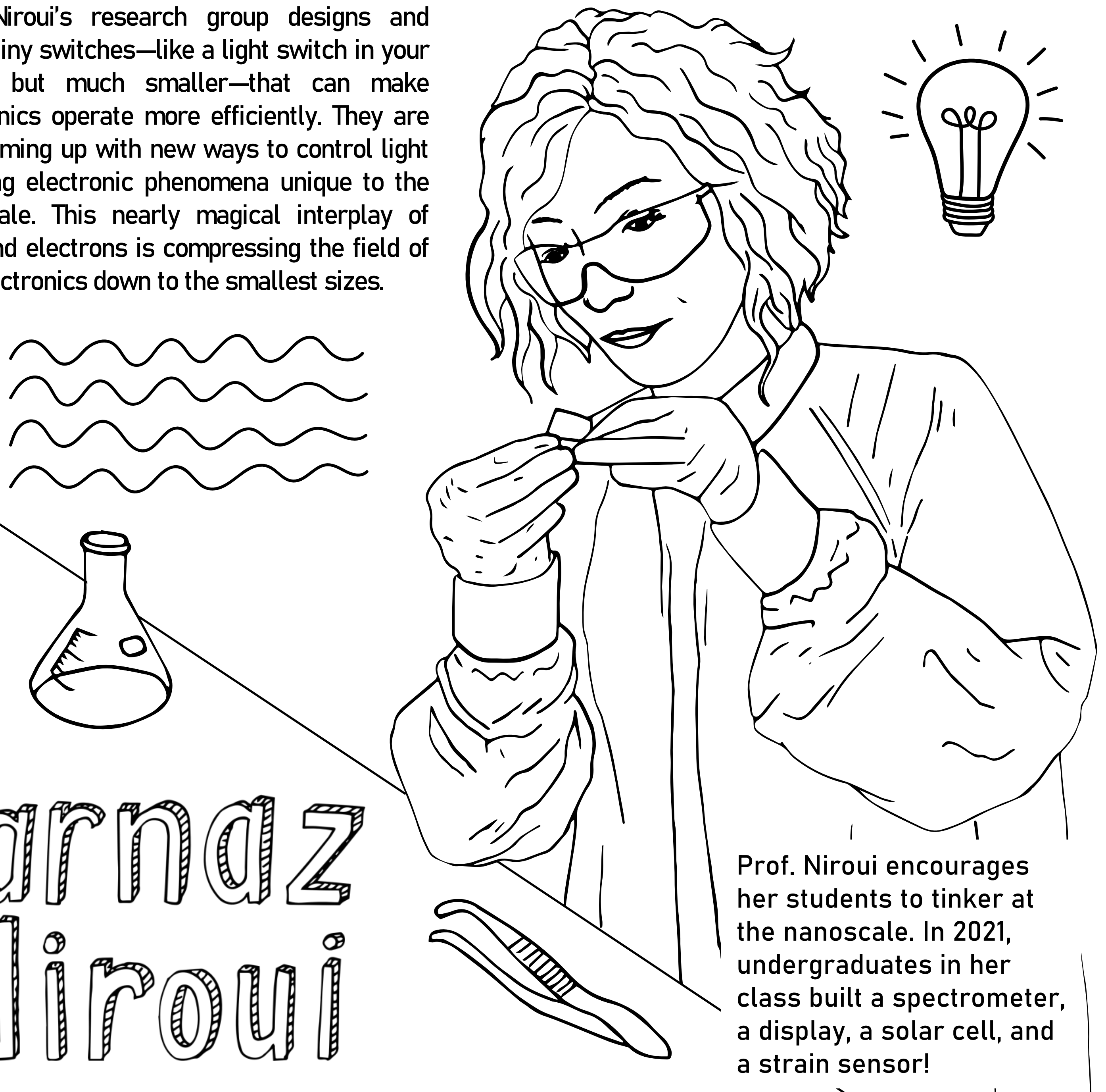
Illustrated by Julie Rorrer, PhD

Julie Rorrer is an Arnold O. Beckman Postdoctoral Fellow in the MIT Department of Chemical Engineering and founder of ColorMePhD. She will be joining the chemical engineering faculty at the University of Washington, Seattle, as an assistant professor in January 2023.

A big problem facing the 21st century is how we're going to power all the electronics we need. Assistant Professor Farnaz Niroui, the Emmanuel E. Landsman Career Development Chair in the Department of Electrical Engineering & Computer Science at MIT, is working on the answer. Her lab combines electrical engineering with materials science and chemistry to rethink electronic devices and develop new ways of building at the nanoscale.



Prof. Niroui's research group designs and builds tiny switches—like a light switch in your house, but much smaller—that can make electronics operate more efficiently. They are also coming up with new ways to control light by using electronic phenomena unique to the nanoscale. This nearly magical interplay of light and electrons is compressing the field of optoelectronics down to the smallest sizes.



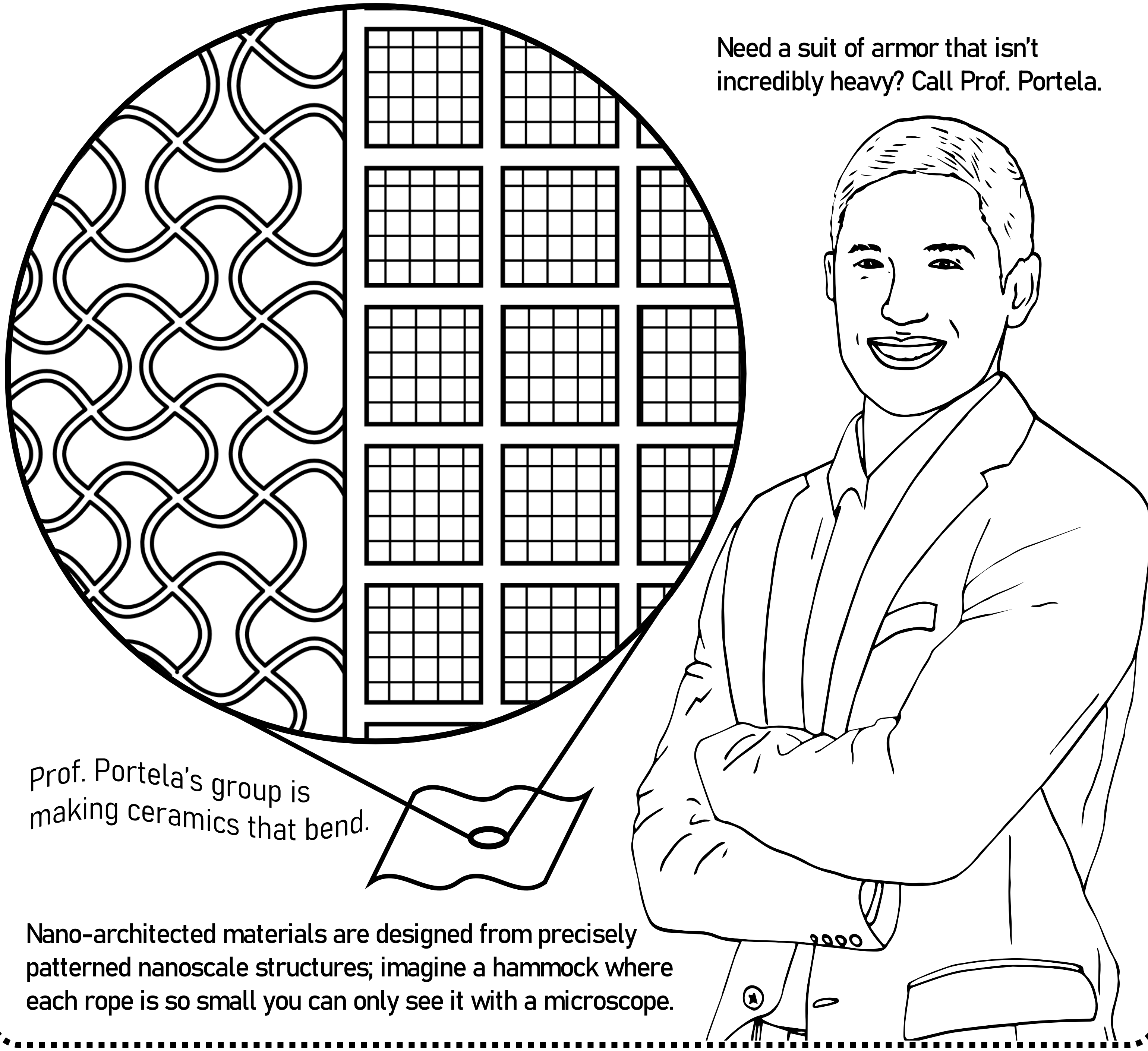
Farnaz Niroui

Prof. Niroui encourages her students to tinker at the nanoscale. In 2021, undergraduates in her class built a spectrometer, a display, a solar cell, and a strain sensor!

Carlos Portela

What if you could build a house with the same amount of material that fits inside a backpack? Assistant Professor Carlos Portela, the d'Arbeloff Career Development Professor in MIT's Department of Mechanical Engineering, can show you how. Prof. Portela's lab is creating their own materials to build objects that are super lightweight, but still incredibly strong. They start at the nanoscale, where materials behave differently, so something you think would break if you dropped it, might actually bounce. Prof. Portela's work focuses not only on nano-architecting materials, but also making them scalable – big enough to use in the real world.

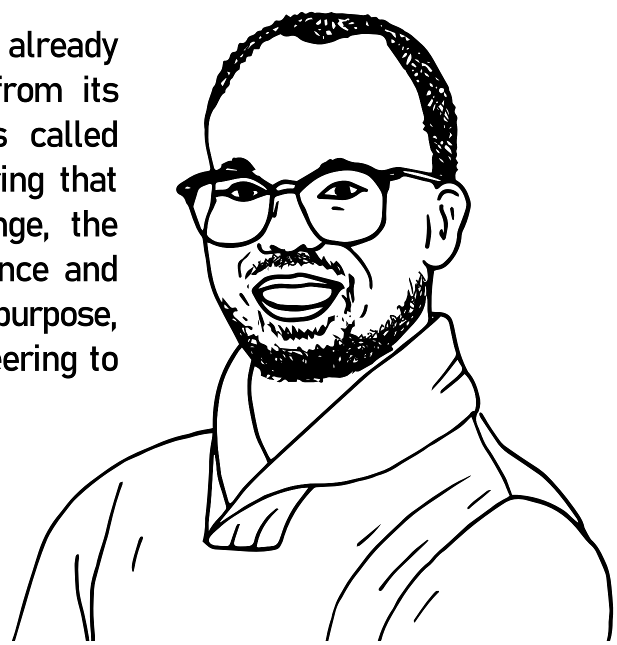
Need a suit of armor that isn't incredibly heavy? Call Prof. Portela.



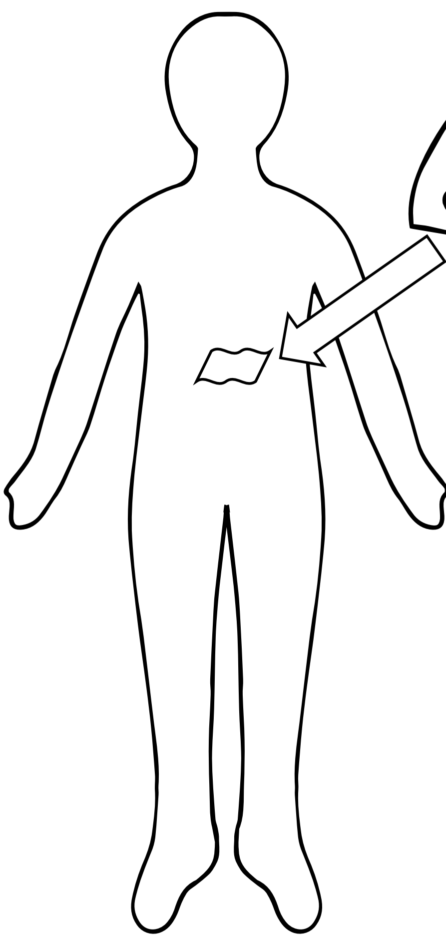
Prof. Portela's group is making ceramics that bend.

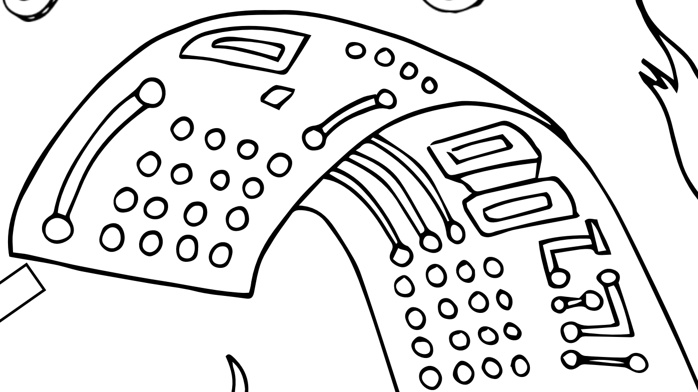
Nano-architected materials are designed from precisely patterned nanoscale structures; imagine a hammock where each rope is so small you can only see it with a microscope.

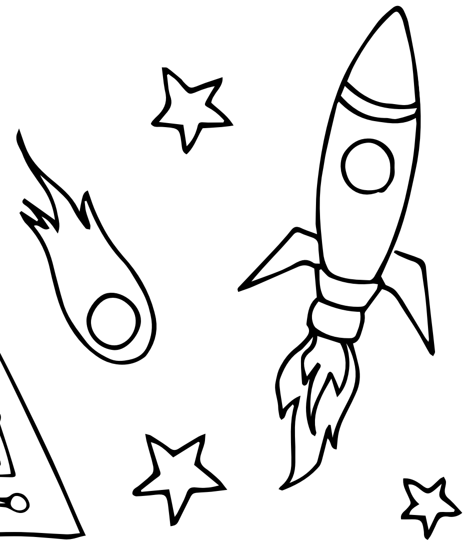
Imagine your computer could think like a human brain. It's already able to store information, but what if it could learn from its environment and recall memories on its own? This is called "neuromorphic computing" - a type of computer engineering that models systems after the human body. Prof. Gumyusenge, the Merton C. Flemings Assistant Professor of Materials Science and Engineering at MIT, is developing organic materials for this purpose, combining biology, materials science, and electrical engineering to create electronics that can act like, and with, our bodies.



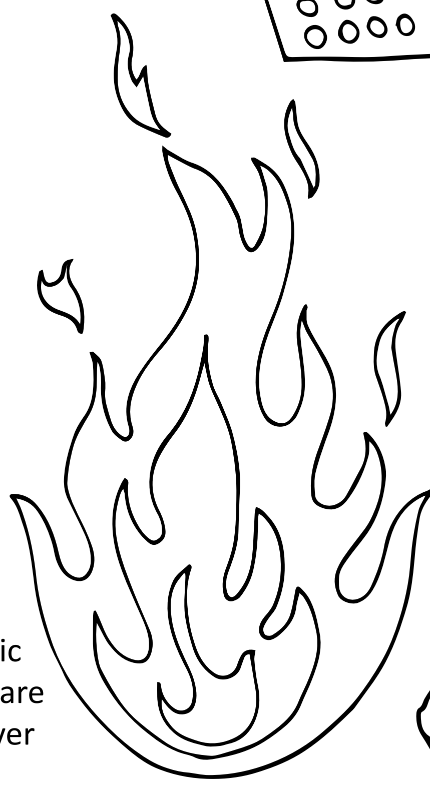
Aristide Gumyusenge

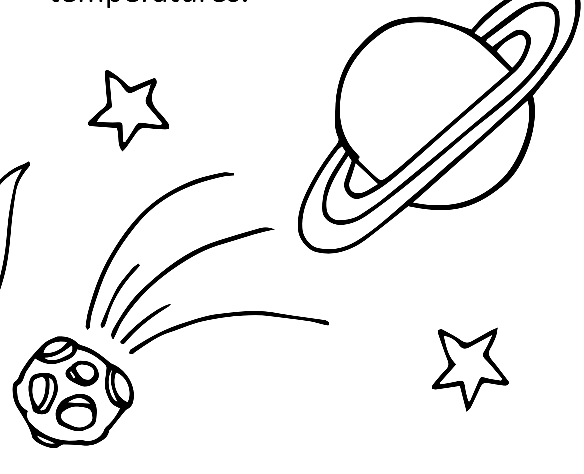






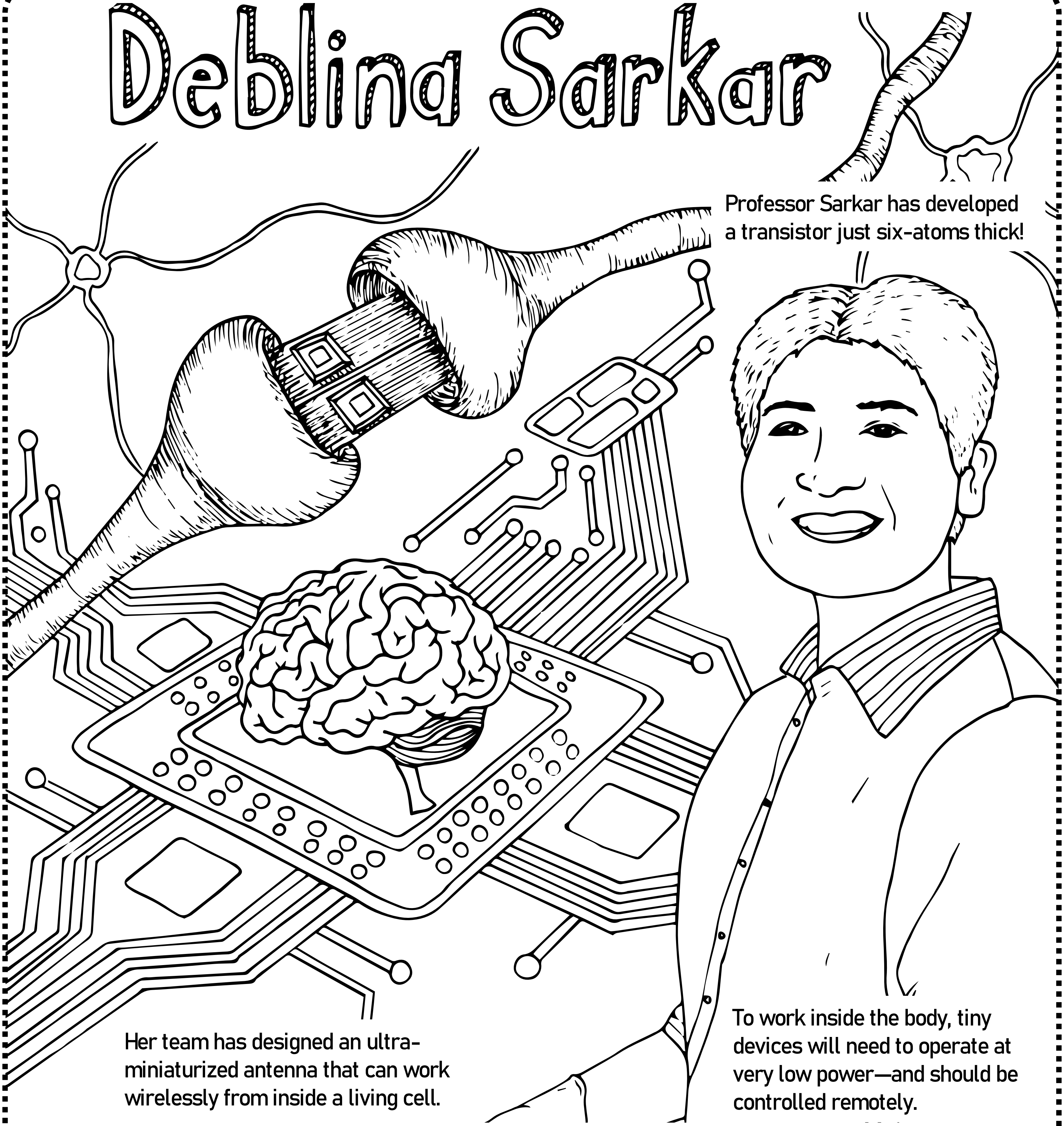
Electronics used in robots that help fight fires – or explore outer space – need to work in extreme heat. Prof. Gumyusenge's materials are designed to be stable at high temperatures.





Prof. Gumyusenge focuses on organic materials for smart electronics that are so small, they could be used to deliver medicine INSIDE our bodies.

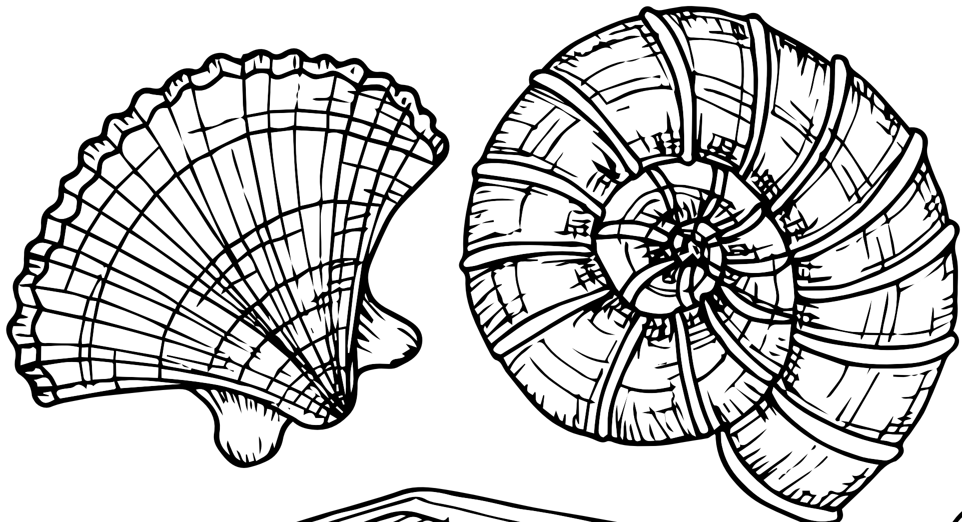
Deblina Sarkar



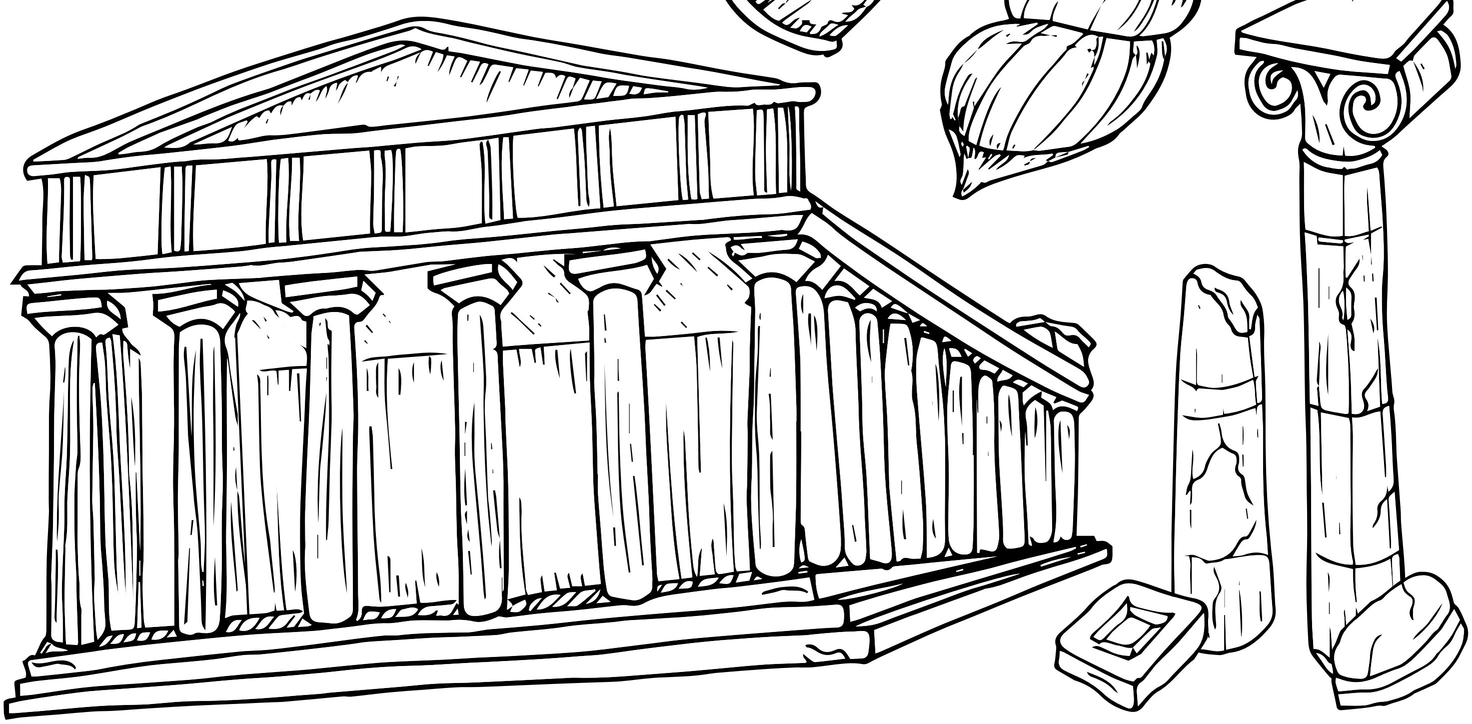
What if your body could talk to electronic devices? Assistant Professor Deblina Sarkar, the AT&T Career Development Chair at the MIT Media Lab, combines an understanding of biology with an ability to design nanoelectronics at scales so small they would work with—or even inside!—human cells. Bringing together applied physics, biology, materials science, engineering, and other disciplines, Professor Sarkar's team, the Nano-Cybernetic Biotrek group, is on an adventurous scientific voyage to invent a new era of human-machine symbiosis.

Admir Masic

What do Ancient Roman concrete and seashells have in common? They are both incredibly strong and resilient, even repairing damage to their structure all by themselves. MIT Prof. Admir Masic, Associate Professor of Civil and Environmental Engineering, is investigating these materials, down to the nanoscale, to figure out what makes them so stable. In their research, Prof. Masic and his students have discovered how different minerals interact to fill gaps in concrete, and how alternating layers of platelets keep shells from cracking. Now, they're using what they've learned to design new materials that are long- lasting, and better for the environment.

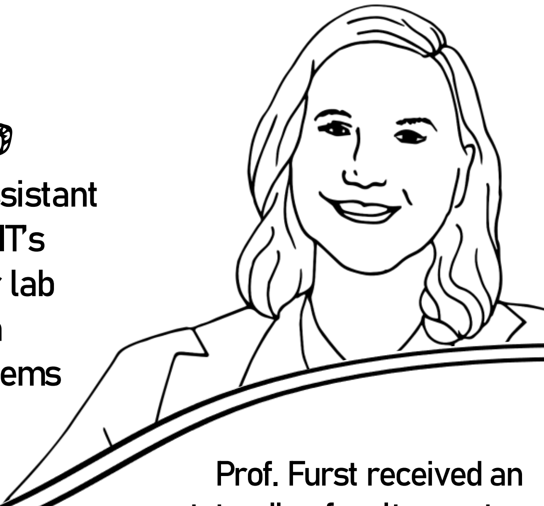


Prof. Masic is the faculty founder of the MIT Refugee Action Hub, an institute-wide effort to develop global education programs for underserved communities.



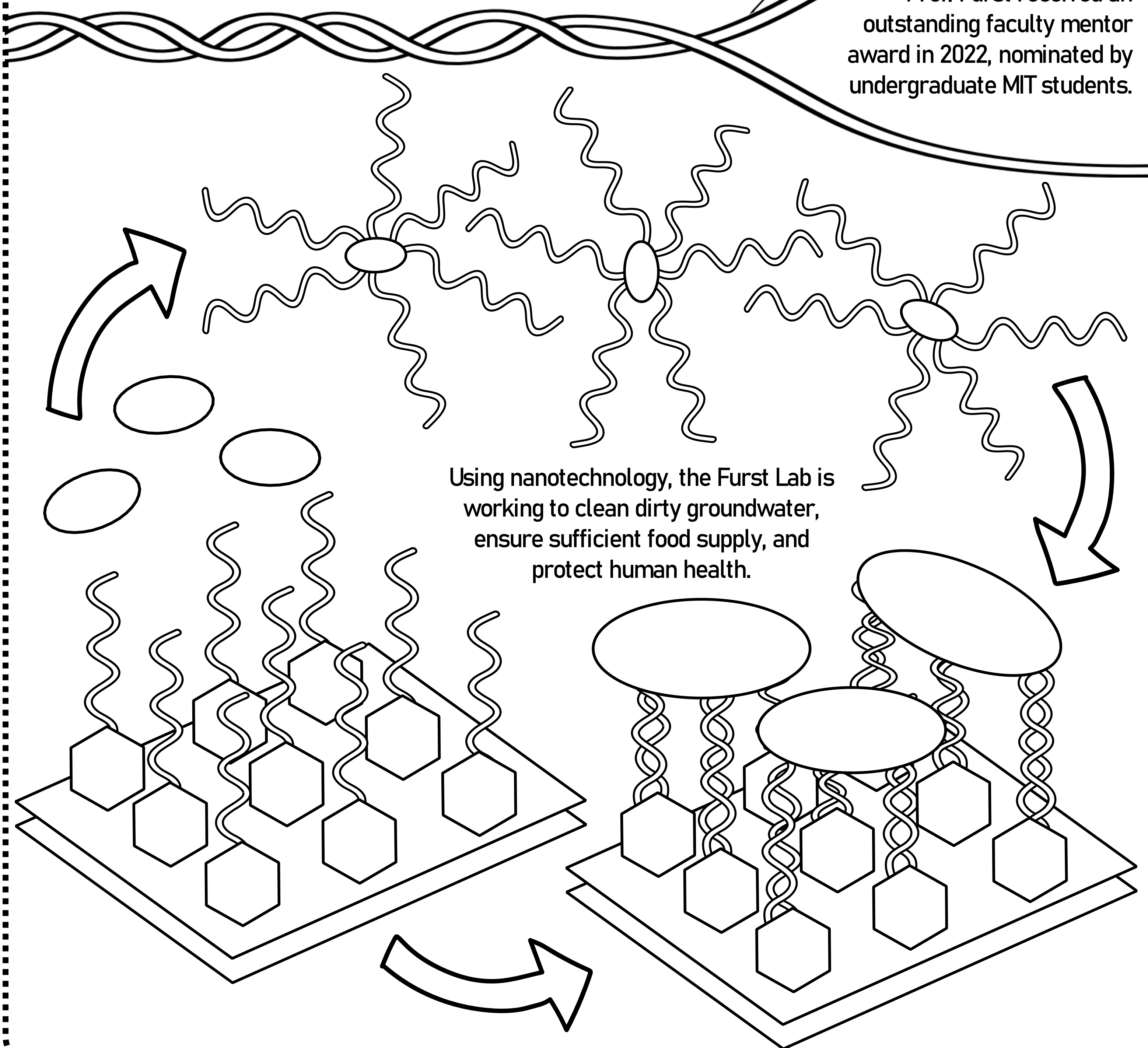
Prof. Masic is also a conservation scientist. He has worked on restoring ancient art and architecture including the Dead Sea Scrolls and the Bernini columns of St. Peter's Basilica in Rome.

Ariel Furst

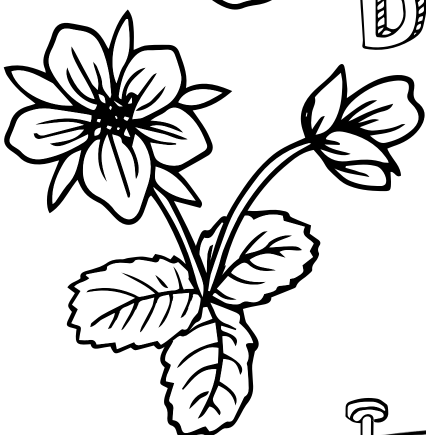


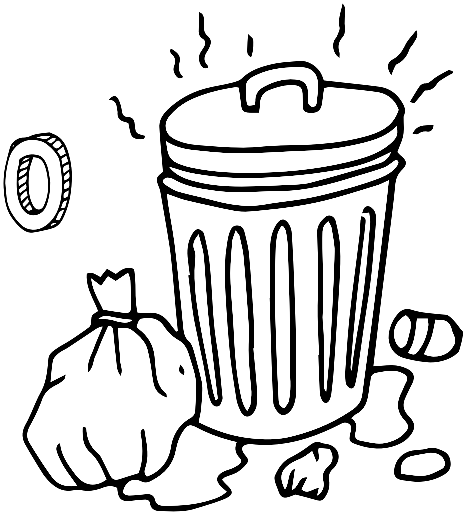
Most people think of DNA as the instructions for how cells work. Assistant Professor Ariel Furst, the Cook Career Development Professor in MIT's Chemical Engineering Department, sees DNA as so much more. Her lab uses short pieces of DNA as nanoscale "Velcro" to reversibly attach molecules, proteins, and even whole cells to electrodes. These systems can be used to generate electricity from microbes, convert CO_2 to valuable chemicals, and make clean energy.

Prof. Furst received an outstanding faculty mentor award in 2022, nominated by undergraduate MIT students.



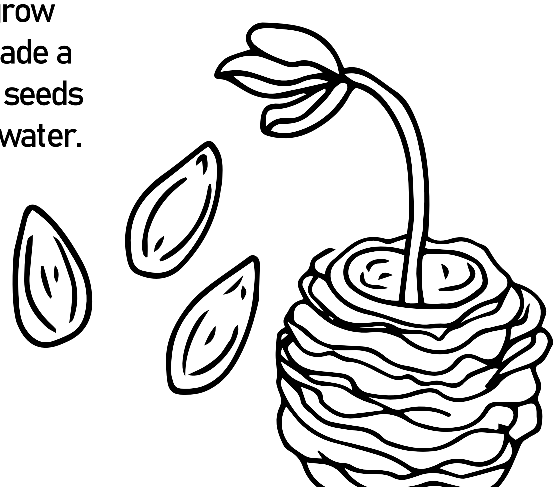
Using nanotechnology, the Furst Lab is working to clean dirty groundwater, ensure sufficient food supply, and protect human health.

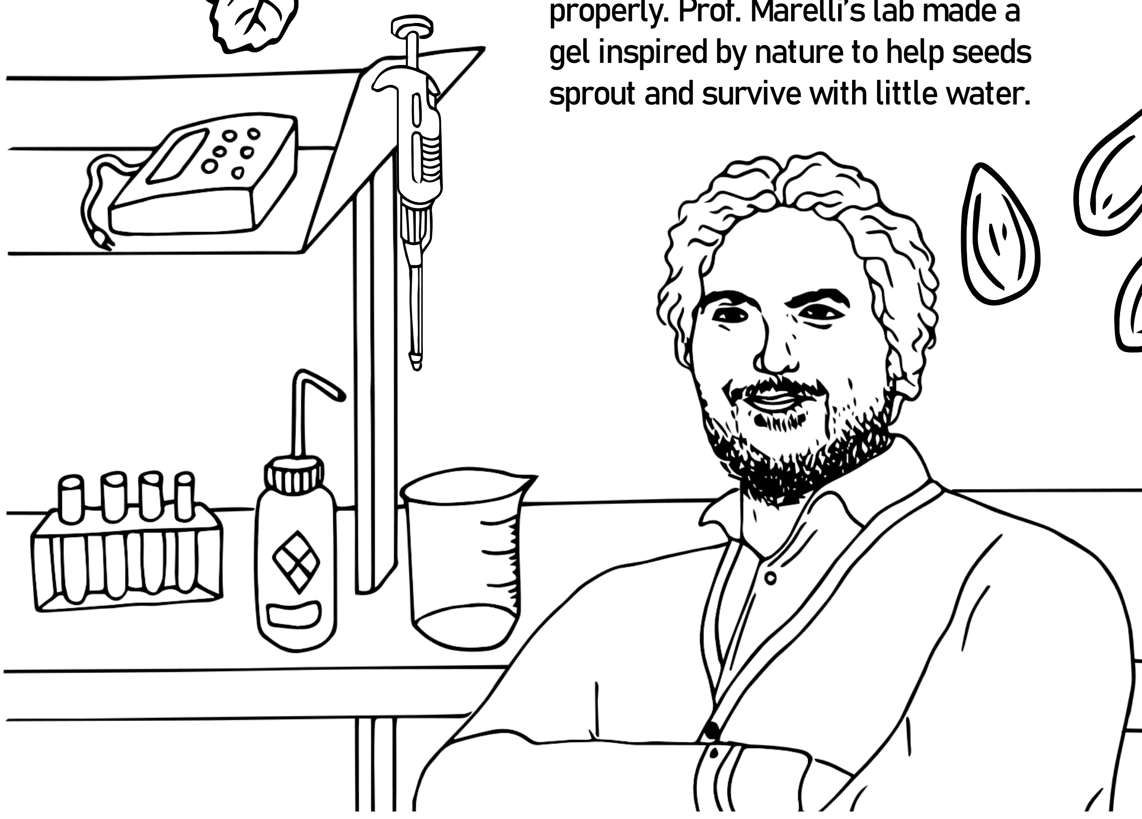




Benedetto Marelli

When there isn't enough rain, seedlings can dry out or not grow properly. Prof. Marelli's lab made a gel inspired by nature to help seeds sprout and survive with little water.

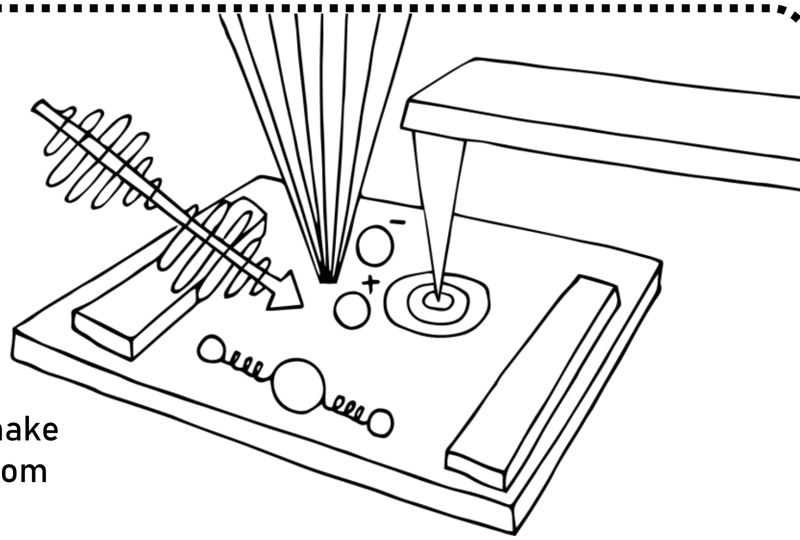




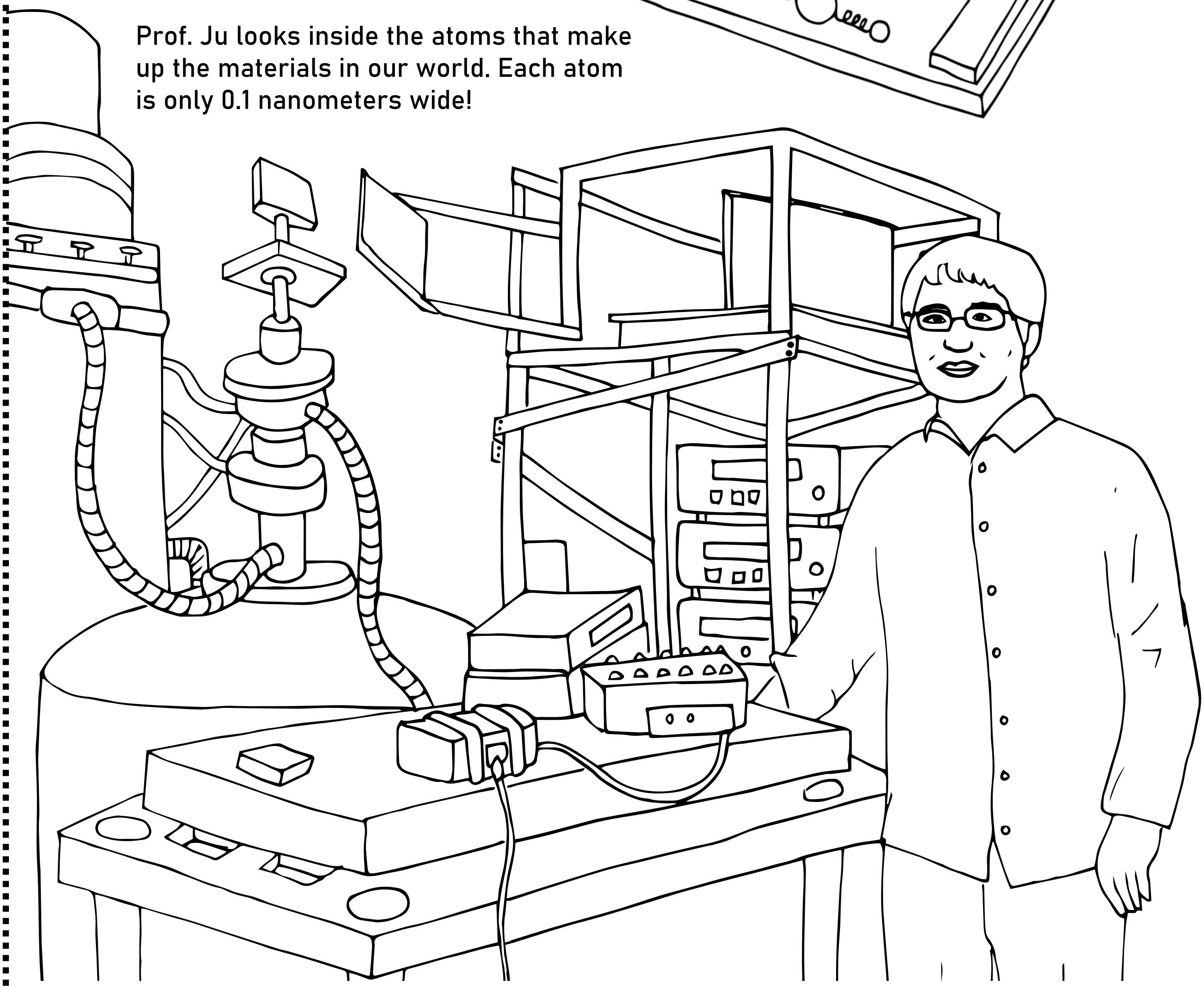
Just like a caterpillar weaves a cocoon to protect itself while it grows, Prof. Marelli developed a type of silk to wrap food in so it lasts longer. The silk is clear and safe to eat!

Many of the products we use everyday are non-degradable, creating piles of trash that are bad for all living things. Benedetto Marelli, the Paul M Cook Career Development Associate Professor of Civil & Environmental Engineering at MIT, wants to protect us, our food, and ultimately the Earth. Using nature as an inspiration and a resource, his lab is designing new materials that are circular—they are safe for the environment and can even break down to become part of nature (instead of trash!). Prof. Marelli's lab is using their new, natural materials to help farmers grow stronger crops and to make our food stay fresh longer, so more people always have healthy meals to eat.

Long Ju



Prof. Ju looks inside the atoms that make up the materials in our world. Each atom is only 0.1 nanometers wide!

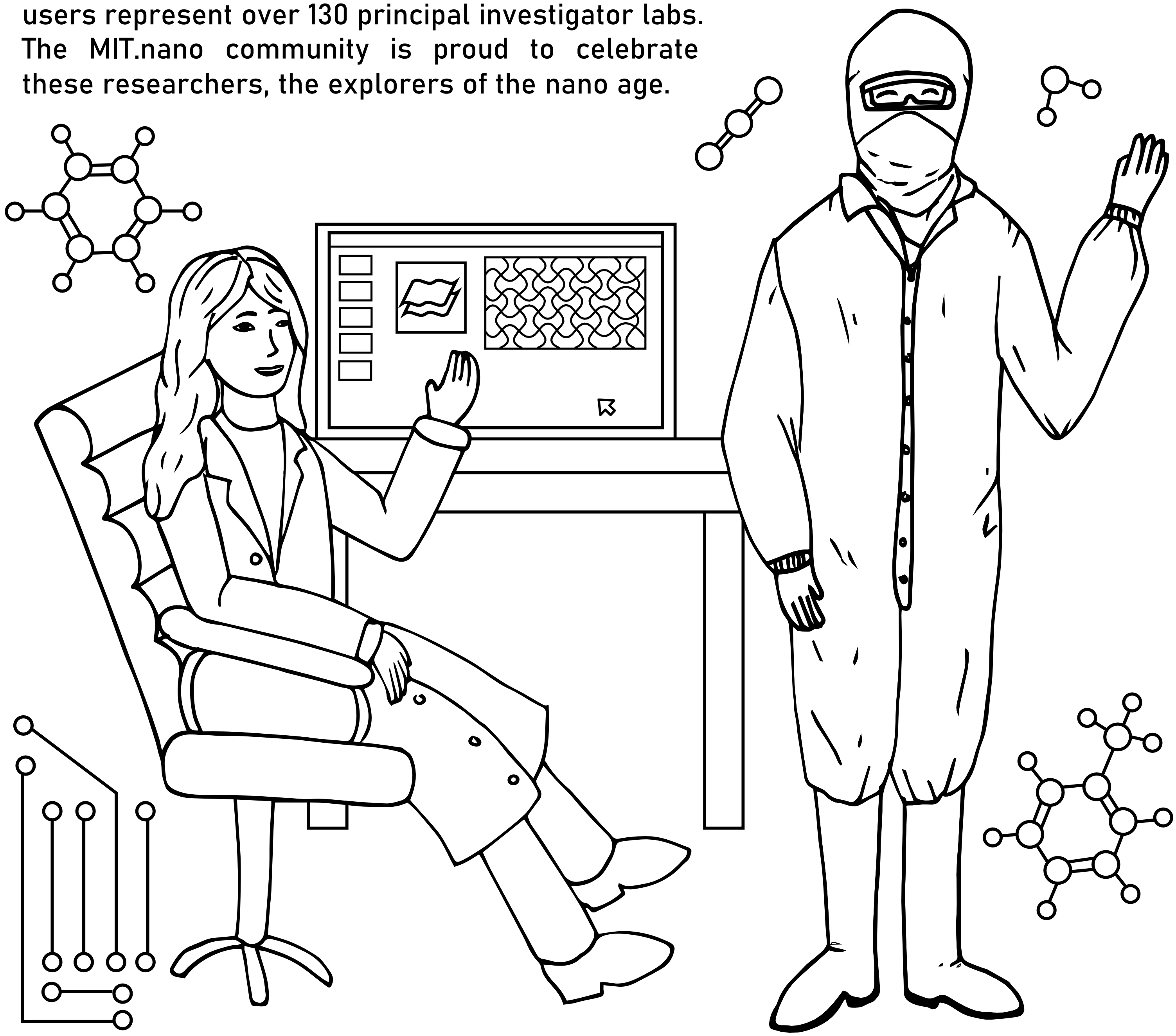


When you make materials thinner and thinner, eventually you will reach the atomic limit where the material is two-dimensional. Understanding these atomically thin materials and how they function at the nanoscale is important for building better electronic and magnetic devices. Long Ju, Assistant Professor of Physics at MIT, is studying how stacking these materials in different ways can change what they can do. His lab, the Nano Optics for Quantum Materials Group, focuses on understanding light-matter interactions in novel quantum materials.

The researchers of MIT Nano

MIT.nano is MIT's open-access facility for nanoscience and nanoengineering. Any qualified MIT researcher, as well as external users, can use our tools and instruments to advance their next set of ideas. As of September 2022, we have over 650 trained users who come from nearly 50 MIT Departments, Labs, or Centers (DLCs). These users represent over 130 principal investigator labs.

The MIT.nano community is proud to celebrate these researchers, the explorers of the nano age.



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