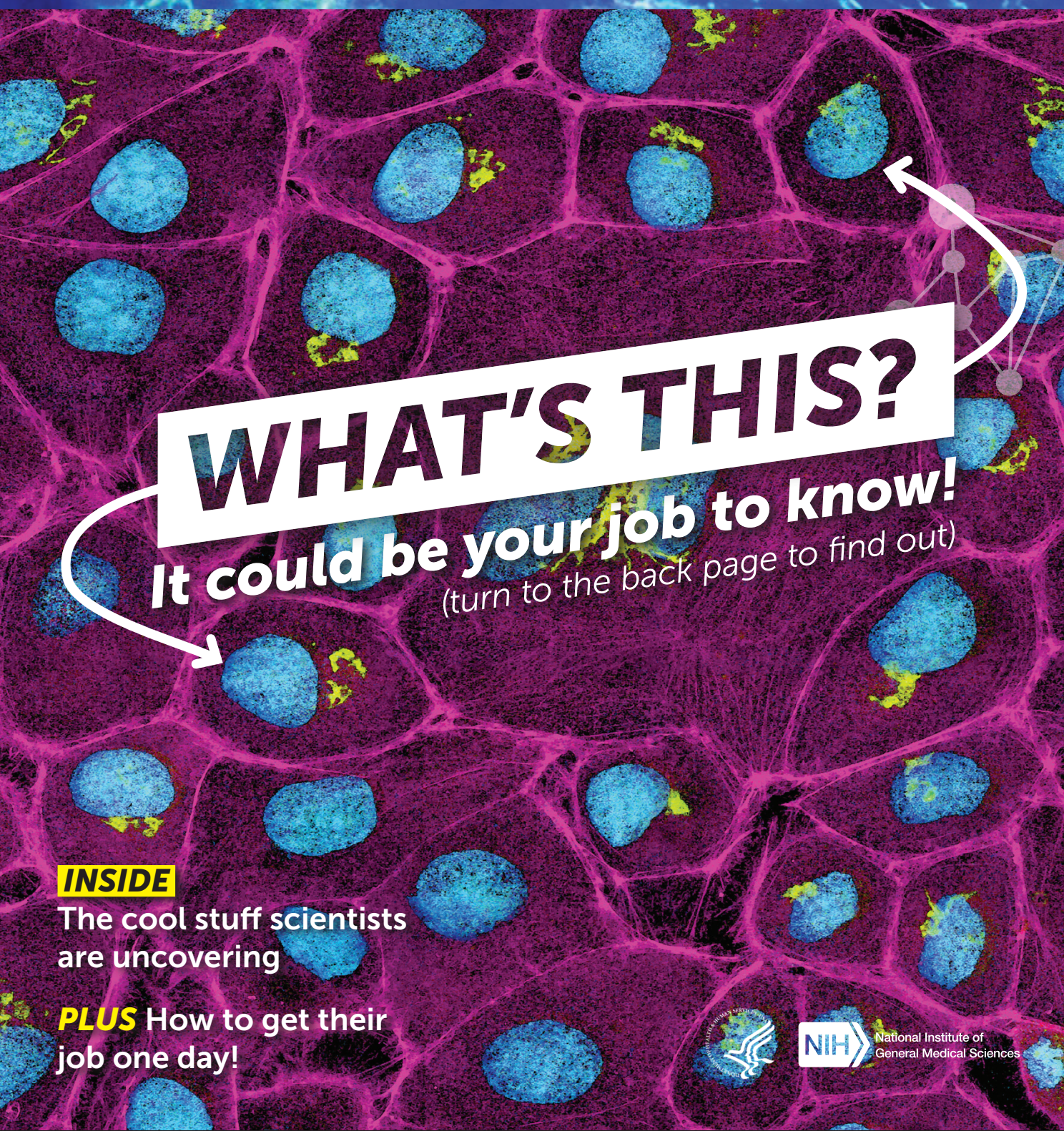
nigms.nih.gov/education/pathways

PATHWAYS



WHAT'S THIS?

It could be your job to know!

(turn to the back page to find out)

INSIDE
The cool stuff scientists are uncovering

PLUS How to get their job one day!

National Institute of General Medical Sciences

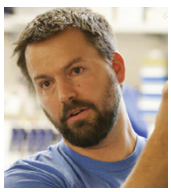
How Curiosity Creates Cures

Look around you. From your fingernails to faraway forests, the whole world is teeming with wonder. See how these scientists are unlocking nature's secrets to improve our health.

Ph.D.
A Doctor of Philosophy is the highest academic degree awarded by universities. It means you've studied a lot!

The Beetle Guy

Ryan Bracewell, Ph.D., postdoctoral fellow, University of California, Berkeley



What do you research? Using bark beetles, I carry out genetics experiments to understand how chromosomes evolve and have led to diversity among living things.

What is most exciting about being a scientist? Some days I'm outdoors using chainsaws to collect bark samples. Other days I'm indoors writing code and analyzing data. Each day I get to do what I love.

Were you interested in science as a kid? I was often in a swamp digging around for creatures. And I was interested in how things worked. It wasn't until later that I realized I could turn these interests into a career.

What would you say to a budding scientist? Ask questions and think about what's going on around you. And always be exploring and following different paths; you may stumble upon things that are interesting and amazing.

A closer look at mountain pine beetles, a species of bark beetle that Dr. Bracewell uses in his research. Females (right) are, on average, larger than males (left).

What Is Basic Science?

The phrase **basic science** doesn't refer to science that's simple—it's actually a scholarly term that refers to the research of figuring out how and why things work in the world around us. Basic science in biology helps scientists understand living systems and find new ways to improve our health.

The Viral Star

Mavis Agbandje-McKenna, Ph.D., professor, University of Florida

What do you research? Viruses. I try to understand the ones that make people sick as well as the ones that don't. I study how they can be used to make treatments or cures.

What kinds of tools do you use? I use a tool called a cryo-electron microscope. It creates detailed images of the three-dimensional structure of a virus.

What's an example of a mistake that you have made? After two weeks of preparing a virus to study, I was cleaning up my station and instead of pouring my waste down the drain, I poured out the virus! I told my boss, and he said, "Mistakes happen—and now you will never do that again." Nearly 30 years later, he was right; I never did it again. In science, failure is going to happen a *lot*. You have to learn from your mistakes.

How would you encourage teens who are interested in science but don't have role models in the field? Don't give up. Reach out to a teacher or a guidance counselor who can connect you with science programs outside of school.

Photo courtesy of Ryan Bracewell

Did you know? Venom from the Gila monster has been found to help treat diabetes.

The Gene Detective

Melissa Wilson, Ph.D., assistant professor, Arizona State University

What do you research? My research focuses on the role genetics plays—and does not play—in shaping life. We're a product of our genes and our environment. It's this cool kind of interplay.

What kinds of animals do you study? We look at the rattlesnake, Gila monster, tortoise, and other animals. But we study humans too!

What's the most important skill a scientist should develop? You need to be open to being wrong. My lab and classrooms are no-judgment zones. Because if we can't ask questions and be wrong or make mistakes, then we're not going to learn.

The Powerhouse

Christian J. Garcia, Ph.D. student, Columbia University

What do you research? Mitochondrial diseases. The mitochondria are the power plants of the cell, so these diseases affect organs that require a lot of energy.

How did you get into this specific field? In fifth grade I started having fainting spells. Doctors didn't know why. After a year and a half, I was diagnosed with hypoglycemia. They changed my diet and I stopped fainting. That always stuck with me, just how powerful nutrition can be.

What are some ways you conduct your research? I use a confocal microscope and gel electrophoresis. I look at mitochondria that aren't working in flies and mice—and research how they can be fixed.

What is essential to your work? Teamwork. I played team sports my whole life, and working in the lab is similar. My lab leader is like our coach—and every person in a lab has something to offer.

The Bacteria Spy

Alecia Dent, Ph.D. student, University of Maryland, Baltimore School of Pharmacy

What do you research? I investigate how bacteria survive during infections.

How did you get into science? Growing up, I attended an underfunded school. We didn't have much of a science program, but once a week in third and fourth grade, a teacher would do experiments with us. It was the coolest class I had. At home, I would try to create experiments in the basement. I didn't have the correct materials, so I would just make things up and observe what happened.

How did you make the leap to becoming a scientist? It was very important to me to find a mentor (an experienced adviser) who was doing things that I thought were interesting and who came from my kind of background. I needed to see that someone coming from very little resources and very few opportunities could do what I dreamed of.

What has helped you succeed? Being open to others. Collaboration is absolutely important—there's no possible way for you to understand every single aspect of something you're doing. It's OK for you not to know things. If everyone knew everything, we wouldn't need science!

Bacteria are microscopic one-celled organisms that can be found everywhere. They can be dangerous, such as when they cause infection, or beneficial, such as in the process of fermentation (making cheese or vinegar) and decomposition.

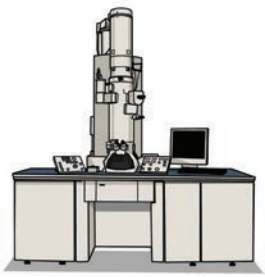
PATHWAYS QUIZ

COOL TOOLS IN SCIENCE

What do you see?

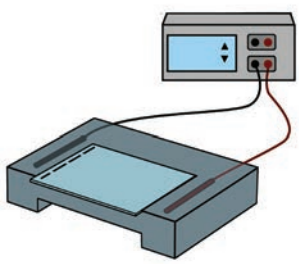
You've read about some unique techniques used in basic science research. Now see some of them in action. Below each image, write the name of the instrument or method used to create the image.

INSTRUMENT/METHOD	IMAGE CREATED



Cryo-Electron Microscopy Typically a transmission electron microscope is used to capture images of a rapidly frozen virus or sample, then computers create clear images of the molecular structure of the sample.

Confocal Microscopy Under intense light, fluorescent dyes added to a sample light up. Photos of different layers of the sample can be stacked together to create a 3D image.



Gel Electrophoresis When charged by an electric current, molecules separate and move through a gel. Colored stains in the gel allow the molecule to be seen.

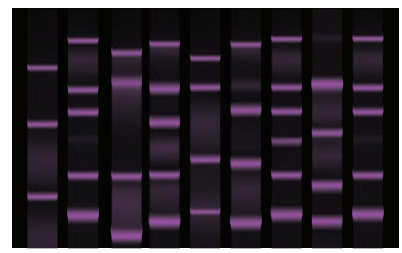


IMAGE 1: DNA molecule fragments

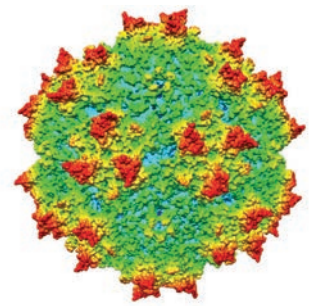


IMAGE 2: Computer-generated structure of a virus

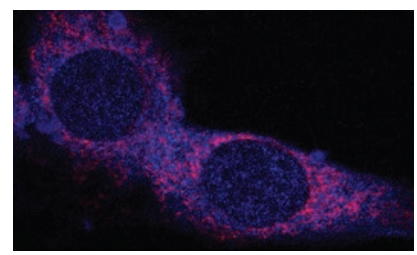
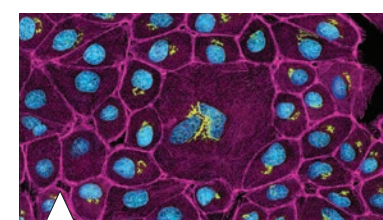


IMAGE 3: Mitochondria inside a cell

Science All-Star: Dr. Michael W. Young

Sports have the Olympics, movies have the Oscars, and in science, the most prestigious award a scientist can win is the Nobel Prize. Named for Alfred Nobel, a scientist and inventor, the Nobel Prize honors men and women from around the world for outstanding achievements in physics, chemistry, physiology or medicine, literature, world peace, and more.

Michael W. Young, Ph.D., a researcher, won in 2017 for his contributions to the study of the circadian rhythm that controls sleep/wake cycles, hormone release, and much more. The work was done using fruit flies. In his acceptance speech, Dr. Young called his scientific work a "remarkable journey." Just think: Some day your curiosity, passion, and collaboration with others could lead you to incredible discoveries—and maybe a few meaningful awards too.



ON THE COVER This image (which was created using confocal microscopy) shows human epithelial cells, a type of cell that lines and protects hollow organs, glands, and the outer surface of the body. Many epithelial cells can produce mucus or other secretions as protective features.

Photo: Tom Deerinck, National Center for Microscopy and Imaging Research

Photos (clockwise from top right) Michael W. Young © Mario Morgado/The Rockefeller University; cell mitochondria photo courtesy of Christian Garcia; structure of a virus photo courtesy of Mavis Agbandje-McKenna; DNA molecule fragments © extender_01/Shutterstock

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