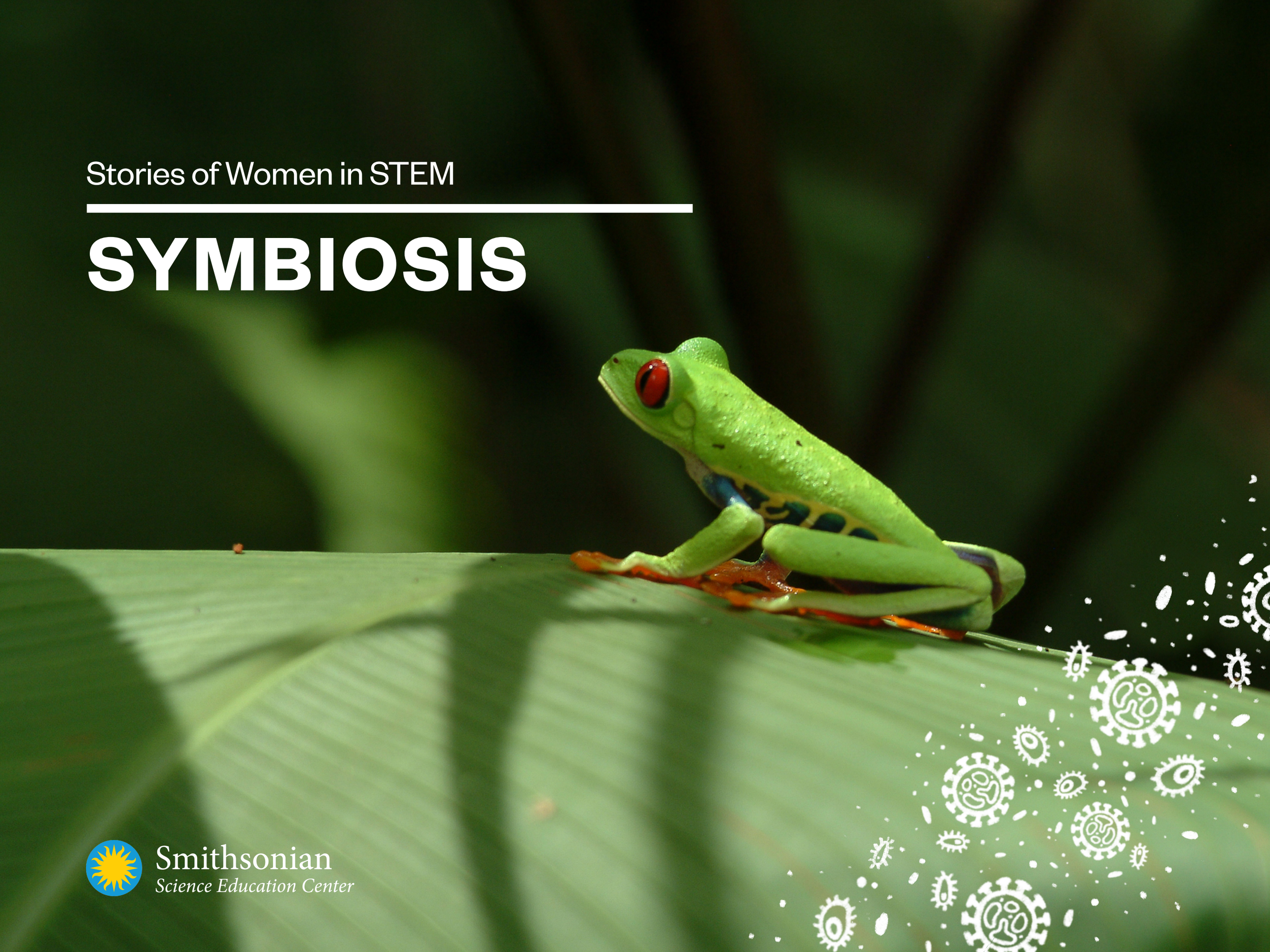
Stories of Women in STEM

SYMBIOSIS



Smithsonian
Science Education Center

The Smithsonian Science Education Center (SSEC) is an education organization within the Smithsonian Institution. The SSEC's mission is to transform K-12 Education Through Science™ in collaboration with communities across the globe. The SSEC promotes authentic, interactive, inquiry-based K-12 STEM teaching and learning; ensures diversity, equity, accessibility, and inclusion in K-12 STEM education; and advances STEM education for sustainable development. The SSEC achieves its goals by developing exemplary curriculum materials and digital resources; supporting the professional growth of K-12 teachers and school leaders; and conducting outreach programs through LASER (Leadership and Assistance for Science Education Reform) to help schools, school districts, state education agencies, and ministries of education throughout the world implement inquiry-based science education programs.

The Smithsonian Institution was created by an Act of Congress in 1846 "for the increase and diffusion of knowledge…" This independent federal establishment is the world's largest museum, education, and research complex and is responsible for public and scholarly activities, exhibitions, and research projects nationwide and overseas. Among the objectives of the Smithsonian is the application of its unique resources to enhance elementary and secondary education.

Cover and layout design by Sofia Elian.

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Introduction

Dr. Carol O’Donnell

Director
Smithsonian Science Education Center

Growing up in inner city Pittsburgh in the 1960s and 70s, I was always tinkering—designing something new and putting my “inventions” in a little notebook. I also loved observing the world around me. In my small backyard, I was always experimenting—studying native plants during the day and observing the stars at night. I didn’t know much about what it meant to study science, technology, engineering, or math (STEM) back then. I just knew that I loved making, testing, experimenting, inventing, and solving problems.

Dr. Carol O'Donnell

In high school, I got my first job at a library as a "Page." I would put books back on the shelf when people returned them, fix books that were broken, and help people find book titles that interested them. Books played such an important part in my life. And it was through books that I was first introduced to what it meant to be a "real scientist."

I don't recall having any women scientists in my life, though. At least not until I went off to college. That's when I got my first job at a museum—the Carnegie Museum of Natural History in Pittsburgh. They had just built the Benedum Hall of Geology and the Hillman Hall of Minerals and Gems. I fell in love with the history of our planet, and went on to get a Masters Degree in Geosciences with a focus on planetary geology.

I also had a second full-time job in college working in the Gastroenterology Lab at the hospital (yes, I worked a lot back then). Mary Mylo was the lab's Director, and I will never forget her. Other than my mother, Mary Mylo was my first "real mentor."

Today, I direct the Smithsonian Science Education Center at the Smithsonian Institution.

I also teach astronomy part-time for the George Washington University Physics Department (yes, I'm still working a lot).

The books and the stories of women in STEM, the STEM mentors and role models I met along my journey, and hard work—they all helped me to achieve my goals.

As a young girl, it is so important to see yourself in the role models around you and in the stories you read. Some people call this the "See/Do" theory. If you can see yourself in others, then you will believe you can do it, too. That is the purpose of this book.

I hope when you read the stories of these amazing women, you can "see" your future self. Then, strive to be the best you can be. Who knows? One day, you might be like Lynn, or Ruth, or Margaret, or Carly, or Amy, or Rita, or Patricia and "do" STEM, too.

Introduction to Symbiosis

Have you ever thought about how two animal species live in the same area and relate to each other, or how plants and animals interact, or even how microscopic bacteria and large animals can affect one another? Many scientists ask themselves these questions. Symbiosis is the relationship or bond between two or more different organisms.

There are three types of symbiosis. The first is called mutualistic. This is a relationship in which both organisms benefit. Examples of this type of symbiosis are ants and acacia trees. The ants live in the tree and protect the tree from animals that try to eat its leaves or bark. In return, the acacia tree makes nectar for the ants to eat. The tree benefits from the protection and the ants benefit from the tree's nectar.

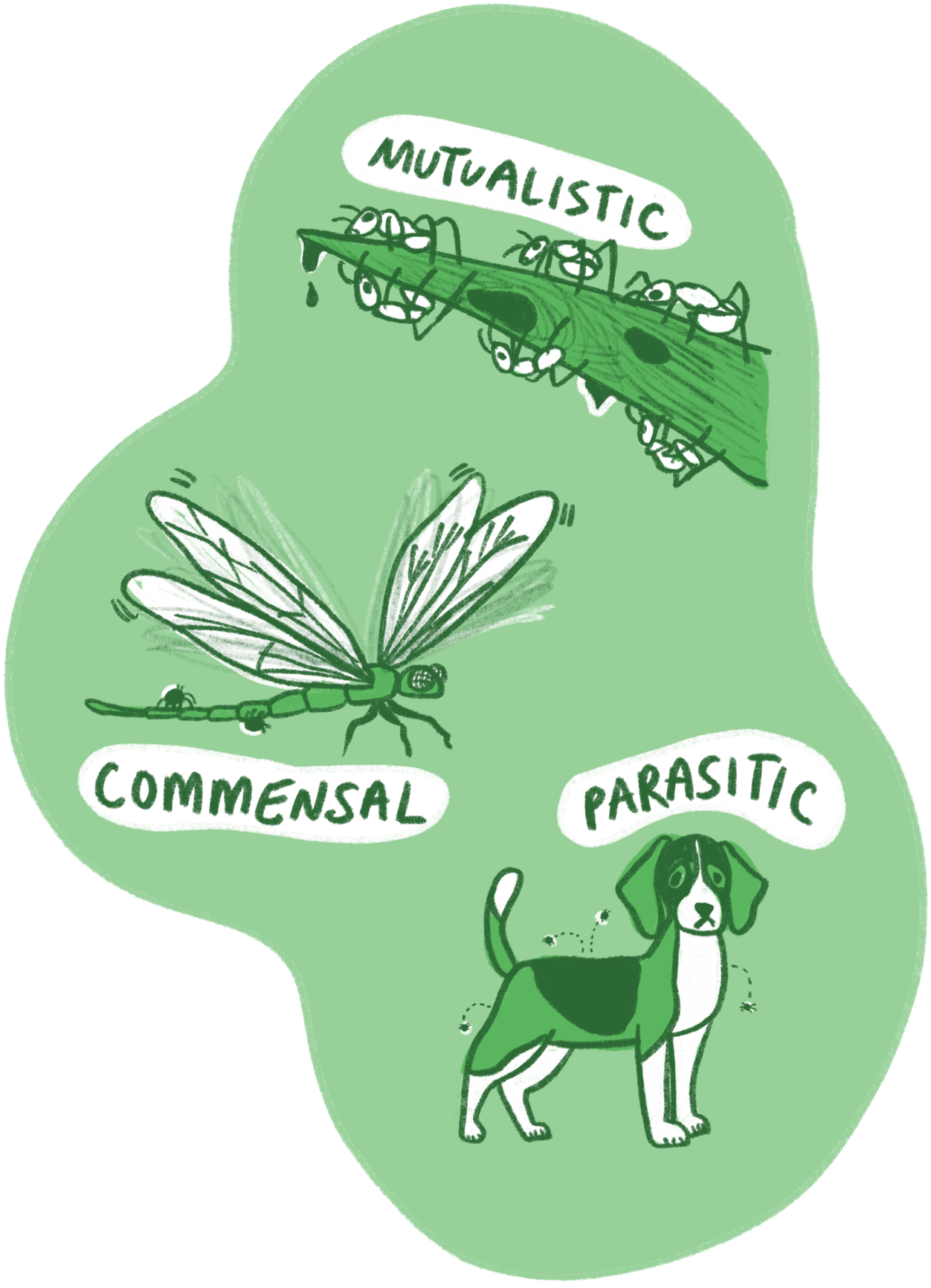
The second type of relationship is called commensal. This is when only one organism benefits from the relationship and the other is not affected.

Introduction to Symbiosis

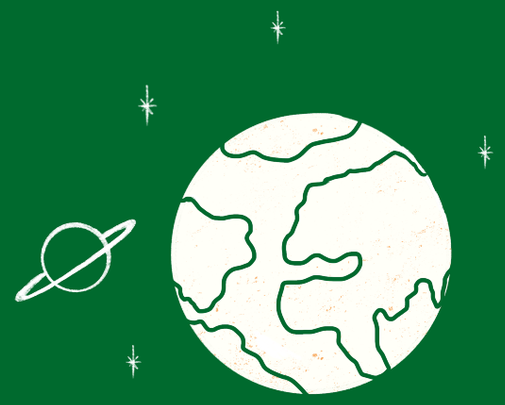
Examples of this type of symbiosis are mites and larger flying insects. The mite benefits by jumping on the larger flying insect and using it to get a free ride. The flying insect does not benefit from the mite, nor is it harmed.

The final type is parasitic. This is a relationship where one organism benefits while the other one suffers. An example of this type of symbiosis is when a tick bites a dog. The tick benefits by feeding from the blood of the dog. The dog suffers because the tick drinks its blood and may give the dog a disease.

Symbiosis connects scientist in many fields. Microbiologists, herpetologists, bacteriologists, and botanists, for example, may come together to study the relationships between organisms from different perspectives. Each of the scientists in this book has a unique story of who influenced them and what lead them into STEM. They come from different backgrounds and are different ages. But much like the different organisms they study, the women in this book are linked through symbiosis.



FOUNDATIONS OF SYMBIOSIS



Dr. Lynn Margulis

Dr. Lynn Margulis

Have you ever thought about how two organisms work together? What happens when two organisms work against each other? How does that affect the environment we live in? These are some of the questions Lynn Margulis worked to answer. She was a biologist who was known for her work in the field of symbiosis.

Lynn was born in Chicago, Illinois, on March 5, 1938. She was the oldest of four daughters. Lynn described herself as a “bad student” in her youth. But she was also praised as being a gifted child. At 15 years old, she got into the University of Chicago Laboratory Schools. She went on to study at the University of Wisconsin in Madison. Her main course of study there was zoology and genetics.

Dr. Lynn Margulis

She soon moved to California to study for her PhD at the University of California, Berkeley. In her program, she learned more about the role of genetics. She went on to have a thriving career. Lynn was a professor at Boston University and taught there for 20 years. In 1988 until her death in 2011, she taught at the University of Massachusetts at Amherst.

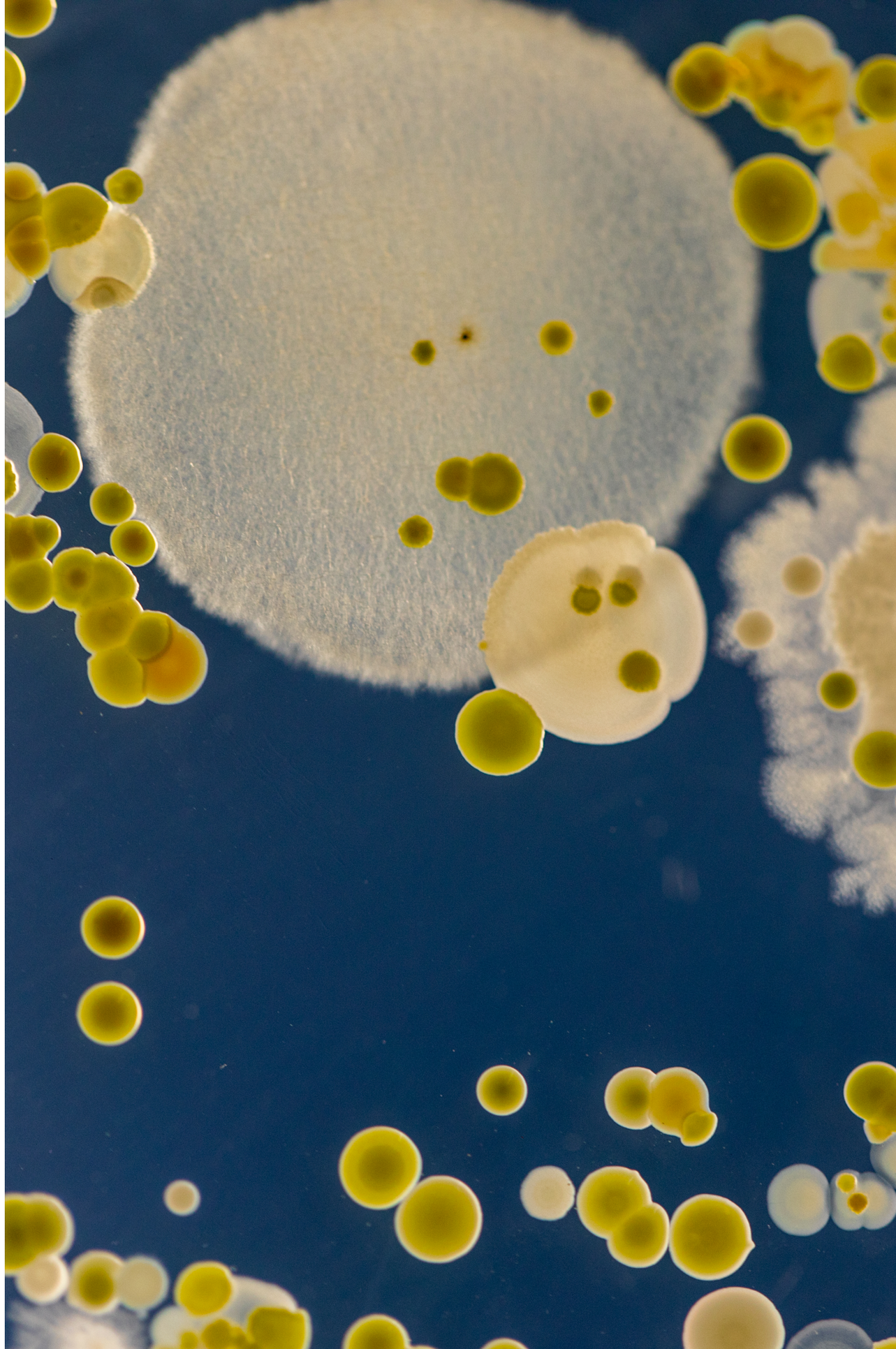
Through her years of research, Lynn was able to carve out her own lane in biology. She became the leading figure in the field of symbiosis. Her work started in 1966 when she wrote her first research paper as a young faculty member at Boston University. Her paper was about how certain cells come from older living organisms. This creates a close bond between two different organisms. They can either benefit one another, be on the same terms, or one is harmed more than the other. These are all symbiotic relationships.

But Lynn's research went against the views of most people who worked in biology at that time. The "survival of the fittest" ideas of Charles Darwin was the accepted theory. But Lynn pushed back against that. What Lynn did not like about Darwin's theory was that it put too much focus on the competition of species. She believed species working together helped evolution take place.

During her career, her peers thought she was radical and she faced criticism. There were some scientists who were not swayed by her findings. It wasn't until the 1980s that her work on symbiosis was accepted. Since then, her research on topics such as cell biology, microbial evolution, Gaia theory, and others have gained acceptance. She has won recognition and several awards for her work. In 1983, Lynn was elected to the National Academy of Sciences. She was awarded the National Medal of Science in 1999 from President Bill Clinton. And the Library of Congress archived her papers in 1998.

Lynn Margulis

Lynn showed that you should never give up, no matter how many obstacles are in your path. She is a trailblazer in the world of STEM. And her work in symbiosis created a new path for future scientists to learn about the world around us.



Dr. Ruth Ella Moore

Dr. Ruth Ella Moore

Many health problems that are easy to treat today were life or death situations in the early to mid-20th century. One of them was tuberculosis.

Tuberculosis germs spread from person to person through the air. The disease was one of the leading causes of death in the early 1900s. There were scientists who worked for years to make sure this illness did not continue to harm people. Ruth Ella Moore was one of them. Because of her important work on tuberculosis, she became a leading figure in the field of bacteriology.

Ruth was born in Columbus, Ohio, on May 19, 1903. She was the youngest of three siblings. Her mother was an artist. Ruth's mother encouraged her to go to college and succeed in whatever she put her mind to. Ruth went to Ohio State University—one of the only few colleges in the United States that accepted Black Americans at the time. She got her bachelor's degree in microbiology in 1926. She then got her master's degree and her PhD in bacteriology.

Dr. Ruth Ella Moore

This was a milestone achievement in the field of science. Ruth was the first Black woman in the United States to earn a PhD in the natural sciences.

The research she did for her PhD paved the way for controlling the spread of tuberculosis. Other scientists referenced Ruth's research as they expanded our knowledge of how to treat this disease.

Ruth moved to Washington, DC, and taught at Howard University for more than 30 years. In 1940, she started as an assistant professor in the school's College of Medicine. By 1952, she was the chair of the department of bacteriology.

Throughout her years at Howard, Ruth continued her research. Her work on the distribution of blood types among Black Americans became the foundation for learning about the blood types of other racial groups. Ruth also studied gut microorganisms. Gut microorganisms live in the stomach, and play a symbiotic role in digestion. She studied the reaction of gut microorganisms to certain types of antibiotics.

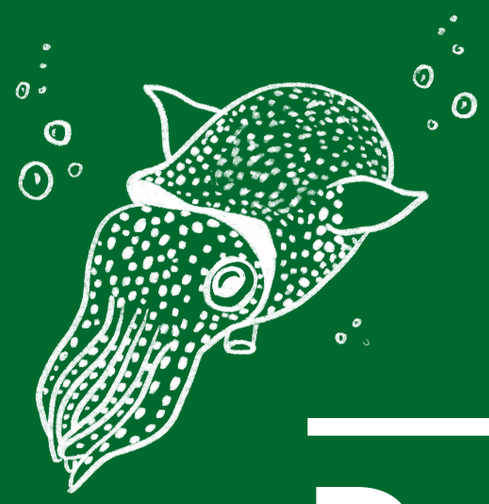
Her research has played a key role in improving people's health.

Ruth passed away in 1994, but her contributions live on. She was awarded honorary degrees from Oberlin College and Gettysburg University. She is in Ohio State's Diversity Hall of Fame. Ohio State also named a student scholarship in her honor.

Ruth also had a passion for fashion design. She created stylish clothes, from tailored suits to colorful dresses. In 2009, her clothing designs were shown at an Ohio State Historic Costume and Textiles Collection showcase.

Ruth's rise within STEM was not an easy journey. She had to face racist and sexist attitudes. This was at a time when many did not believe she was worthy of respect. She proved everyone wrong, and made a positive impact on the people around her and on the world.

CURRENT RESEARCH



Dr. Margaret McFall-Ngai

Dr. Margaret McFall-Ngai

Dr. Margaret McFall-Ngai is a microbiologist doing important research today. Microbiology is the study of organisms that are hard to see with the naked eye. Some examples of this are viruses, bacteria, and some parasites and algae. “I would like to pioneer this new area and reshape the field of biology,” Margaret said.

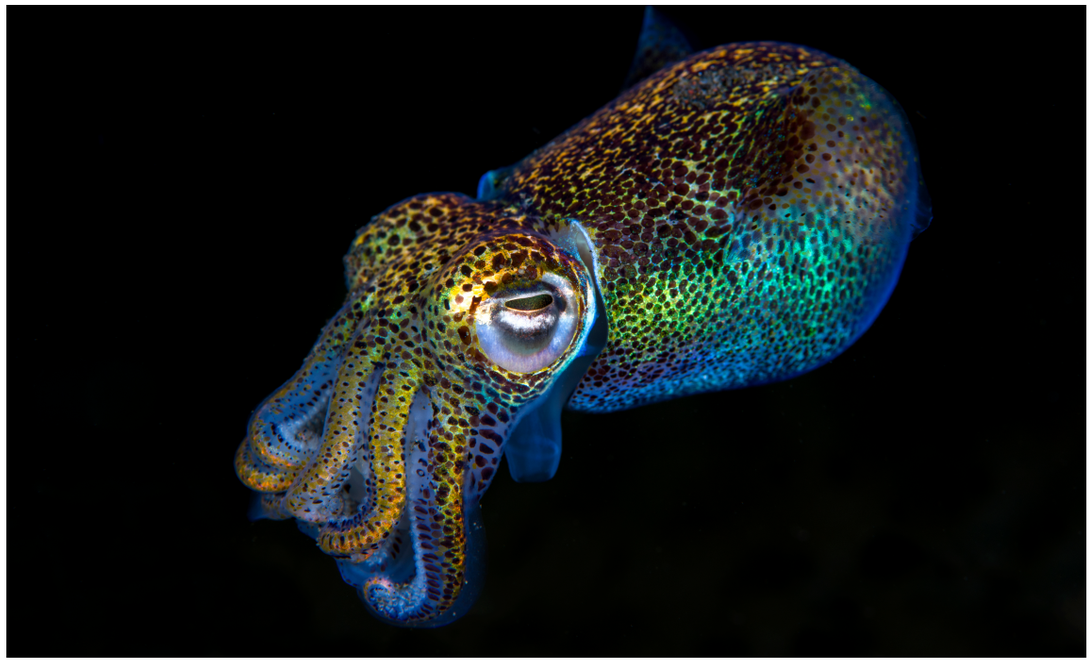
Her interest in STEM began in middle school. Her most memorable experience from that time is when she won a math award in eighth grade. Her love for STEM continued in her high school in Los Angeles, California. “What was great in my high school is that learning was fun,” Margaret said. “The teachers made up brain teaser games for STEM subjects that were creative.” Margaret would work in groups and sometimes stay late after school so she could play STEM games.

Dr. Margaret McFall-Ngai

After high school, she went to the University of San Francisco to study biology. After graduating, Margaret wasn't sure what career path to take. She became a chemist for PepsiCo. After a year, though, she missed being in a place of learning. So she continued her graduate studies at the University of California, Los Angeles (UCLA). At UCLA she worked as a teaching assistant and fellow. With the support of her advisor, James Morin, her research took her to the central Philippines. In the Philippines, she studied the impact of bacteria found in the organs of fish. This type of bacteria emits light that can be seen in seawater and on the surface of a dead fish.

"I had a fabulous time as a PhD student," Margaret said. "From then on, I knew I wanted to be a professor at a top research university."

In 1983, Margaret got her PhD in biology. At the University of California, San Diego, she worked in the field of biochemistry. This field of science studies how chemicals affect living things. In her free time, Margaret looked into the traits of the bobtail squid.



Biology is a field that is always changing as new discoveries are made. Biologists use model systems to understand how complex things are. An example of a model system is the growth of an egg to an animal. Another example is the wiring of the nervous system. Margaret made a model for the bobtail squid and its symbiotic relationship with a certain kind of bacteria that helps make it glow. This is what she is known for.

Over the years, Margaret has worked at three universities. She is now the director of Biosphere Sciences and Engineering at the Carnegie Institution for Sciences.

Margaret likes to give back to others. That is what she is most proud of. "My greatest success has been helping in the training of a number of high school, undergraduate, and graduate students and postdocs," she said.

Dr. Margaret McFall-Ngai

She believes women and girls should be treated as equals in STEM and be challenged. “There should be competition and games that require groupwork,” Margaret said. “Which women do very well in.”

Dr. Patricia Burrowes

Dr. Patricia Burrowes

The outdoors was home for Patricia Burrowes when she was growing up. She grew up in Cali, Colombia, and she spent the summers in the mountains and surrounding cloud forests. At an early age, it taught her to respect nature and all it had to offer. She loved nature so much that it led to her interest in biology. As a child, she wanted to be a field biologist.

“Going into the forest and early encounters with colorful snakes and frogs frightened my friends,” Patricia said. “But they fascinated me with their body shapes and fascinating behaviors.”

As Patricia grew up, she started to do more activities outdoors. She went horseback riding and on hikes in the mountains. Her parents saw how much she loved nature. They wanted her to learn more about the environment around her.

“My parents loved to read,” Patricia said. “Books on nature parks and encyclopedias were always available at home for me. [I could] look up the animals that I had observed and learn more about them.”

Dr. Patricia Burrowes

When she was young, Patricia and her family went on a vacation to an island in the Caribbean called San Andres. The island is known for its coral reefs, water sports, and diversity of wildlife. She was in awe of the coral reefs and how beautiful they were. Patricia said she learned about how the coral reefs play a role in the ocean's ecosystem. She spent hours looking at a single fish's colors and interactions. Patricia also realized that sea cucumbers were animals when she saw them move in the sand. That sense of discovery was exciting, and it never left her.

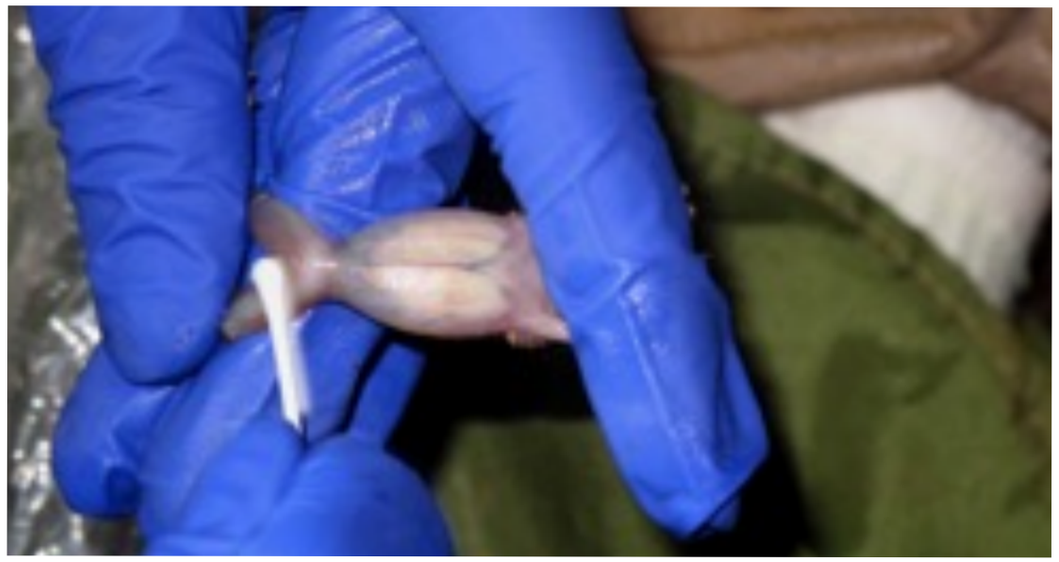
Patricia left Colombia after she finished high school. She moved to the United States to go to college at Iowa State University in Ames. She went on to study animal ecology while she was there. Animal ecology looks at the symbiotic relationships between animals and the area they live in. Iowa State is where Patricia also realized that having good teachers can help you grow.

Patricia said she had teachers who made learning fun. They would go on field trips to see animals in the wild. They would also do lab activities to learn more about them. She spoke to park rangers and nature guides, with the idea of having a job in that field. At the time, she did not know that she could have a career as a scientist. But that changed when she worked as an undergraduate research assistant for her professor, Dr. Marilynn Bachmann.

"I realized that I liked the challenges and the excitement of discovery from an academic viewpoint," Patricia said. "At this point, it became clear to me that I needed to continue graduate studies."

Patricia went to the University of Kansas to get her master's degree and PhD in biology. While there, she worked with her advisor, Dr. William E. Duellman. He was known for his research on tropical amphibians in Central and South America. Patrician went to La Planada, which is a nature reserve in southern Colombia. In La Planada, she found 39 different species of amphibians. Twelve of them were new species! Patricia got to describe all these new species to science, with the help of other experts.

Dr. Patricia Burrowes



Doing field work in Colombia and other remote places helped her make great discoveries. But it did come with challenges. “I had to travel to remote places where roads were terrible,” Patricia said. “And transportation means were sometimes not very safe.”

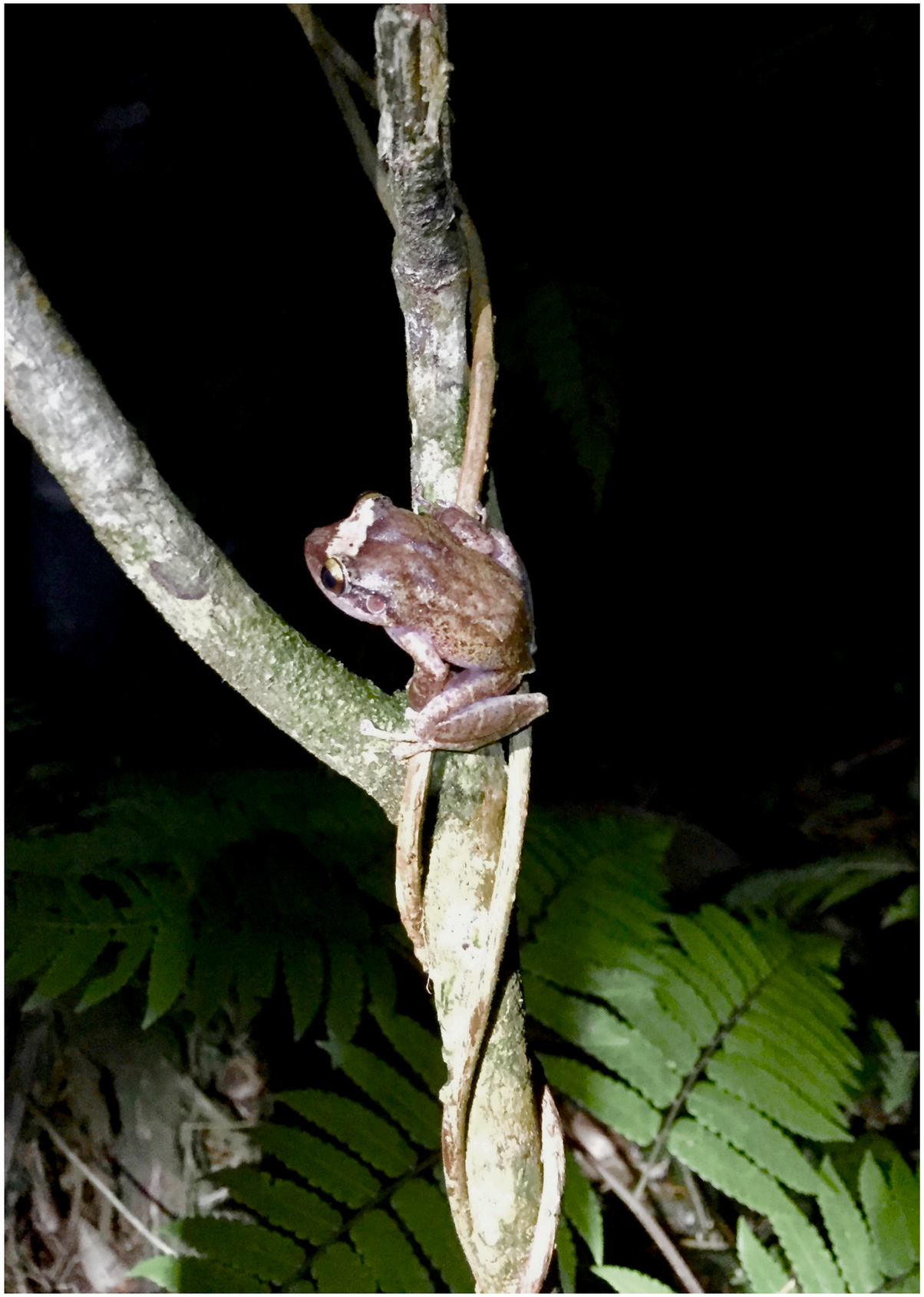
At times she had to deal with the threat of guerilla fighters. She also had to worry about mosquito and chigger bites when going through the Amazon. The thin air with less oxygen in the high Andean Mountains was another big concern. But despite these challenges, Patricia was able to do valuable research.

Patricia decided to study the reproductive biology and the population genetics of a particular cave frog for her PhD. This cave frog is native to the southeastern corner of Puerto Rico. After she got her PhD, Patricia got a teaching and research position at the University of Puerto Rico, San Juan. She has been there since 1998.

Her work is in the field of herpetology. Herpetology is the study of amphibians and reptiles. The populations of wild amphibians are declining all over the world. Patricia said there are a few reasons why this is so. Climate change and the spread of diseases are two problems that have hurt amphibians. Patricia conducts research at the Amphibian Disease Ecology Lab at the University of Puerto Rico. At the lab, she tries to figure out what is causing amphibian populations to decline.

“There are several graduate and undergraduate students that work in my lab under my mentorship,” Patricia said. “These students work on projects related to amphibian disease dynamics, and receive training on state-of-the-art research skills.”

Dr. Patricia Burrowes



Her lab has done research in other countries, but Patricia's work takes place in Puerto Rico. Recently, they have been looking at the mountain population of the coqui frog. The coqui frog is special because it's been able to thrive despite also being harmed by a deadly fungus.

"In the lab, we also study their immune response," Patricia said. "And [we study] the composition of symbiotic bacteria in their skin through seasons, ages, and different microhabitats."

In her free time, Patricia likes to read, go hiking in the mountains, snorkeling, and scuba diving.

Dr. Patricia Burrowes

Patricia makes sure her classroom is a welcoming place. She helps her students learn core science concepts and put them to practice. She also wants women and girls in STEM to have a good support system. Patricia believes girls need more ways to break into STEM fields. She said volunteering at a research lab while in high school would be a good opportunity for them to get that experience.

“I think the key to motivating young girls to pursue STEM careers is to offer them opportunities to get involved in research projects as early as possible,” Patricia said. “Well-prepared women are as competent as well-prepared men in this field.”

Dr. Carly Muletz-Wolz

Dr. Carly Muletz-Wolz

Carly Muletz-Wolz had a lot of interests growing up. But the thing she most liked to do was learn. She loved her American history class. She read the textbook all the way through because she enjoyed the stories about people in the past. Carly also loved learning Spanish and took all the Spanish classes she could while in high school.

“I just enjoyed being young and following whatever path interested me at the time,” Carly said.

In middle school, she wanted to be an astronomer. Carly knew that to be an astronomer she had to take science and math classes. She loved to study these subjects. Her path to becoming an astronomer was as clear as day to her. After high school, she went to college to study physics and Spanish. Carly stayed in her hometown of Frostburg, Maryland, for college, and went to Frostburg State University (FSU). But while there, her interest changed from physics to biology. Her professor, Dr. Amy Harmon, was a major reason for the shift.

Dr. Carly Muletz-Wolz

“When I was taking her biology class, she told me, ‘You should be a biology major,’” Carly said. “Dr. Harmon was my only female professor in biology as an undergraduate student. She was an inspiration to me.”

One of her most memorable experiences with Dr. Harmon was working on a research project. Carly worked with her to document a new type of nematode. A nematode is a tiny roundworm. The images of the nematode were taken with microscopes. The images Dr. Harmon and Carly took were used to show that the species was new to science.

Carly also had the chance to study in Costa Rica. She took an ecology class there, and her passion for biology was set from then on. In her final year at FSU, she figured out what she wanted to do as a career. Carly thought being a biology professor was a great career path, so she was determined to do whatever it took to become one.

Carly applied to graduate school after getting her bachelor’s degree. But she didn’t get into any of the schools the first time she applied. She also had a hard time with the science and math on the entrance exam, and started to have some doubts about her career. “I studied hard, but sometimes still didn’t get all the answers correct,” Carly said. “It was discouraging sometimes. But I enjoyed the discovery aspect of science, so I always just stuck with it.”

Her hard work soon paid off. Carly finally got the news she was hoping for. She got accepted to James Madison University in Virginia and got her master’s degree in biology. She then went on to get her PhD at the University of Maryland in College Park. She said her experiences in graduate school helped her to thrive in her career.

Dr. Carly Muletz-Wolz

“As I continued into graduate school, I really started to identify mentors and find greater support from others on how to pursue my interests,” Carly said. In her first year at the University of Maryland, she worked with her advisor, Dr. Karen Lips, on a project that was a part of the Smithsonian National Zoo & Conservation Biology Institute. She also got the chance to work at the Center for Conservation Genomics. The center was run by Dr. Rob Fleischer, who was a partner on the Smithsonian project as well.

After getting her PhD, Carly took a few months off to have a baby, then started looking for a job. Luck was on her side when Fleischer listed a new job at the National Zoo & Conservation Biology Institute. The position was for a molecular pathogen scientist. Carly applied for the job, got it, and has been at the National Zoo for six years now.

In her job, Carly studies microorganisms and their symbiotic relationships with plants and animals. She studies microorganisms that can only be seen through a microscope, and looks at their DNA.

AT THE SMITHSONIAN

The Center for Conservation Genomics is at the Smithsonian's National Zoo and Conservation Biology Institute.

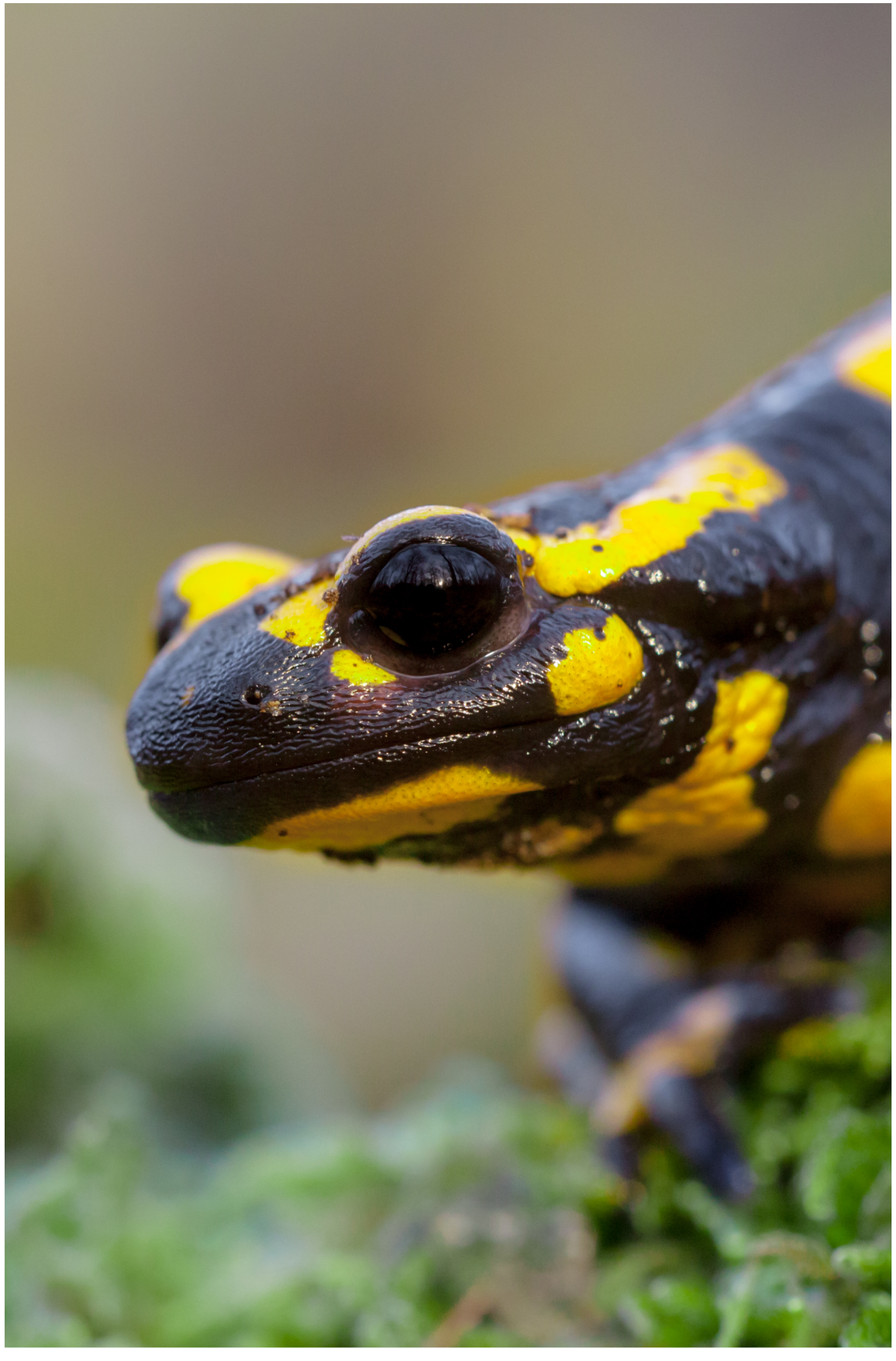
Dr. Carly Muletz-Wolz

She also studies macroorganisms such as salamanders, wolves, and cheetahs. She looks into how microorganisms that live inside these animals keep them healthy or make them sick. She studies the animals' DNA, their microorganisms, and how the plants and animals live in different environments.

Carly said she has a holistic view of plants and animals. That means "thinking about how the smallest molecules and microorganisms inside organisms relate to their health," Carly said. "And how their health relates to the health of the environment around them."

Carly likes to study the impact of pathogens (organisms that cause disease) and how they affect an amphibian's life. Amphibians, like frogs and salamanders, spend part of their lives in the water and part on land. She looks at a certain type of microscopic fungus called amphibian chytrid that has had a deadly effect on amphibians.

"I study this to solve the mystery of why some amphibians die, while others do not," Carly said, "in hope of saving amphibians in the future."

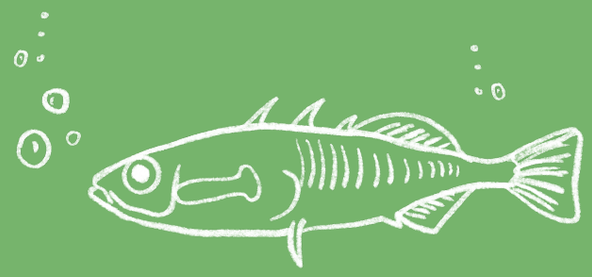


Carly Muletz-Wolz

Carly particularly loves studying salamanders. She said salamanders are very special because they play a big role in food webs and carbon cycling. Because of how important they are, how pathogens affect salamanders is also important. “Salamanders are often referred to as ‘jewels of the forest’,” Carly said. “It’s just that they can be hard to find, and people don’t think about them as much as species we more easily see. But they are there!”

Carly said her biggest success so far is getting her PhD. Through her setbacks, she was able to work hard and have the career she hoped for. She wants her experience to be an example for women and girls not to give up.

“An important area of a STEM career that is often overlooked is the value of finding a good mentor,” Carly said. “We need to remember to tell ourselves, and for people to tell young girls and women that we are smart, successful, intelligent, confident, ambitious, skilled, and outstanding. Then we may help many young girls and women to start to believe this truth about ourselves.”



Dr. Amy Ellison

Dr. Amy Ellison

As a child, Amy Ellison always liked to explore new things. One of her first memorable trips was going to the Natural Science Museum in London. When she entered, she saw a display that caught her eye. It was a statue of a dinosaur that scientists had named Dippy. Soon after, Amy's parents recorded a documentary for her to watch. It was about a fish called a coelacanth and how it lived in its natural habitat. She loved the film so much that she watched it several times. These experiences opened up the door for her future career.

"It was then I first began to understand what a scientist is," Amy said. "And that you could pursue a career in research of the natural world."

Amy grew up in a rural area in Great Britain. While other students were into pop culture, she was exploring the outdoors. She would go into the woods and look for newts and frogs in the pond. Amy said some people found her interest in animals weird. But her biology teacher was good at listening to her.

Dr. Amy Ellison

“I had a fantastic biology teacher, Mrs. Vaughn,” Amy said. “She played an important role in my interest in natural sciences. My other teachers were less thrilled with my interest in zoology.”

Amy went to college to study geology and archaeology. But after a year, she dropped out of college and went back to her hometown. She worked as an administrative assistant for a few years. During this time, she worked at a company that sold supplies for ecological research. She said working there inspired her to go back to college. This time, she decided to study zoology.

Amy said her academic tutor, Dr. Hazel Wright, helped her decide what she wanted to pursue as a career. Dr. Wright worked as a researcher in the field of parasitology. That means studying symbiotic relationships where one organism benefits while the other one suffers. “She gave me the opportunity to do a summer internship,” Amy said. “I studied the impact of parasitic infections on the behavior of stickleback fish.”

Amy got to know other postgraduate and postdoctoral students during her internship. This experience made her realize she wanted to pursue a career in research and get her PhD. She was accepted into a PhD program at Aberystwyth University in Wales, which is in Britain. “I studied the role of parasites in the evolution of mating systems,” Amy said. “I used the mangrove killifish as a model [for my research].”

After she got her PhD, Amy did research at Cornell University in New York. She worked with her advisor, Dr. Kelly Zamudio, to study how the genes of amphibians are harmed by a deadly pathogen. Then she went to Cardiff University in Wales. Amy’s research there focused on fish health in a closed space. She wanted to see how fish respond to infections.

Dr. Amy Ellison

She was then able to pursue her interest in chronobiology. Chronobiology studies the daily cycles of living organisms.

In 2019, Amy became a teaching and research lecturer at Bangor University in Wales. Her main field of study is chronoparasitology. Amy studies the immune systems of animals that host parasites. She tries to find out if fighting infections is harder if a host's sleep patterns are disrupted. An example of this is raising farmed fish under artificial lights. "There is still a great deal to understand," Amy said. "I believe it is an important new area of research in the field of symbiosis."

One way to find out more about host-parasite links is through new technology. Amy believes next-generation sequencing (NGS) technology is the answer. This technology enables researchers to quickly determine the DNA sequences of living things. NGS is becoming easier to access around the world and much less expensive, Amy said. This has helped scientists study the genes of hosts and their parasites. Amy said this access will enable scientists to do more research that deals with host-parasite connections.

When she isn't in the classroom, Amy enjoys going on hikes and canoeing. She also likes photography and playing computer games.

Looking back at her career so far, Amy admits that it hasn't been easy. But with the right people around her, she was able to make it. "Thanks to the incredible support from my mentors—all of which have been women—I had the confidence to stick to it and achieve my career goals," Amy said. "I wouldn't be here today without them. They continue to inspire me to support students and early-career researchers to go after their goals."

Dr. Amy Ellison

Amy said mentorship is a great way for more women and girls to be supported in STEM. “I was lucky to have the support and mentorship of women at the forefront of their fields. As I have become more established, I am better aware of the work that still needs to be done to encourage young women into STEM fields.”

Amy believes highlighting the successes of women scientists from different backgrounds is a great way to inspire others. She said it can bring about a more inclusive space in STEM. She said, “I think working together on a global scale is one of the most rewarding aspects of STEM careers.”

Dr. Rita Rossi Colwell

Dr. Rita Rossi Colwell

For Rita Rossi Colwell, a picture is worth a thousand words. She got a box camera as a gift when she was ten years old. Rita was excited to use it. She set up a darkroom in her house and started taking pictures. She was able to develop the film to produce creative photos. This is where her interest in science began.

“It was great fun,” Rita said. “It was clearly based on science and experimentation.”

She liked to see how her experiments came together. So it’s no surprise that chemistry was her favorite subject in high school. But it wasn’t easy growing up as a girl interested in science in the 1940s. Rita said not everyone took her love of science seriously.

“The chemistry teacher didn’t think girls could do chemistry,” Rita said. “He would not write a letter of recommendation for college so that I could study chemistry, even though I received an A for that course.”

Dr. Rita Rossi Colwell

This wasn't going to be the last time she came up against prejudices about girls and women. But she didn't let these experiences stop her from going after her goals. Rita's father believed both boys and girls should have a good education. He pushed her to pursue her passion. She went to Purdue University in 1952. Rita liked chemistry at first. But then she took some classes in biology.

"In my junior year, I had the good fortune to be able to take a bacteriology course taught by Dorothy Powelson," Rita said. "She was an active teacher who introduced the world of microbiology in a captivating way."

Dr. Dorothy Powelson was the only female professor in the field of biosciences at Purdue. In her class, Rita enjoyed the lectures and doing lab experiments. From then on, she knew she wanted to be a microbiologist. Purdue was a leader in the study of genetics at that time. Rita's studies at Purdue were a big step for her career.

She also met her future husband, Jack Colwell, at Purdue. Rita and Jack moved to Seattle. She went to the University of Washington to get her PhD in marine microbiology. Rita worked for a professor, Dr. John Liston, who had just arrived from Scotland.

"I started work as a technician, and helped Dr. Liston set up his laboratory," Rita said. "And very quickly I was enrolled as his first PhD student in marine microbiology." Her job was to study the bacteria and viruses in the ocean and ways to identify them. She created a taxonomy of marine microorganisms. Taxonomy is a scientific way to classify things.

Rita was able to use the first high-speed computer for her research. It was the first computer the University of Washington had bought. The computer was an IBM 650. For the 1960s, this was a game-changer. She wrote the first computer program to identify and describe bacteria in seawater and on marine animals.

"This was a major development in my career," Rita said. "With my work in genetics, it was a good preparation for a career in the 21st-century biological sciences."

Dr. Rita Rossi Colwell

Rita was able to have a successful career in science. Fighting for access to clean water is important to her. In 1975, she worked on research in Bangladesh. She showed that the bacteria that causes cholera was in the near shore, rivers, and ponds where the people get their drinking water. The bacteria were a part of the copepod population. Copepods are tiny animals that live in water and can only be seen through a microscope.

Cholera was a huge health problem in Bangladesh. An easy solution came out of Rita's research. It was possible to show women in Bangladesh how to use a sari cloth to filter pond water. This method can remove the plankton carrying deadly cholera bacteria.

"Simple filtration is a good thing to have in remote villages [that are] without a way to access safe drinking water," Rita said. "Especially for the very young and very old in those poorer regions of the world."

Dr. Rita Rossi Colwell

She works with the Safe Water Network. This is nonprofit organization that helps set up water filters for communities. It is now working in Ghana and India and is planning to help in other countries. Rita said the water filter units set up in villages in Ghana and India provide safe water that is affordable to all. Now, the Safe Water Network is working on ways to reach more people so they, too, can have access to clean, safe drinking water.

From 1998 to 2004, Rita was the director of the National Science Foundation. In 2001, terrorists mailed out letters that contained anthrax, a deadly disease. Rita was asked to be the chair of an interagency committee that included the FBI and the CIA. “We used our knowledge to track down the source of the anthrax used in the terrorist event,” Rita said. “We did succeed. However, it was a five-year ordeal. That, to me, was far too slow.”

This experience led her to go into business for herself. In 2008, Rita found her company, CosmosID. CosmosID works to find and identify microorganisms in the gut and on the skin of humans. Rita studies the symbiotic relationships between these microorganisms and the humans they live in and on.

Rita has gone through ups and downs in her career. She wrote a book about her experiences in STEM called A Lab of One’s Own: One Woman’s Personal Journey Through Sexism in Science. Rita hopes that people will learn from her book not to give up on their dreams. For Rita, this is especially true for girls and people in minority groups.

Rita has worked her way up despite the odds. She wants women and girls to do the same. She believes girls who are interested in STEM need to be supported in their goals. Rita also said having women in STEM is important for every country to succeed, be safe, and be economically strong.

“I believe it is important for society that women be able to pursue and thrive in careers,” Rita said. “This is especially true in STEM careers, if girls are interested. I want them to succeed.”

THE FUTURE

Your Identity Map

In this eBook you have learned about symbiosis and scientists who study it. Each of the scientists had a unique path in their career. Our different experiences, backgrounds, and ideas give each of us a unique identity. Your identity is what makes you, you. Our different identities often lead to different perspectives. Perspectives are the way we think about the world around us. Understanding your own identity and perspectives can help you understand other perspectives. This activity will help you think about your own identity. Could you be part of the future of the symbiosis field?

Your Identity Map

1. Take out a piece of paper and title it **“Identity Map.”**
2. On the paper, write your **name** in the center of the page or draw a **small picture of yourself**.
3. Draw a circle around your name or picture.
4. Answer the question, “**Who am I?**” or, “**What describes me?**” The list below can give you some ideas to consider, but you choose what you want to include. You can also include things that are not on the list. Record anything you can think of that is important to who you are.
    - *Age*
    - *School or class*
    - *Race and/or ethnicity*
    - *Gender*
    - *Country or place where you live*
    - *Groups you belong to*
    - *Country or place that is important to you or your family*
    - *Ideas or beliefs that are important to you*
    - *Topics or subjects that interest you*
    - *Hobbies or things you like to do for fun*
    - *Physical traits (such as tall, black hair, blue eyes, wears glasses)*
    - *Personality traits (such as loud, funny, sad, kind)*
    - *Roles you have in your household (such as big sister, helper, cousin)*
5. **Write each answer** on the page around your name. **Draw a line** between your name and each answer.
6. **Share your Identity Map** with family and friends to find out what you have in common.

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