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EXPLORATION IN BIOLOGY



DR. CATHERINE WORKMAN
Vice President of Science
National Geographic Society

Hi! I'm Catherine Workman, Vice President of Science for the National Geographic Society. As part of the Science & Innovation division, I oversee our research, conservation, and technology grant-making. At the National Geographic Society, exploration of the planet is in our DNA, and we have awarded more than 15,000 grants since our founding in 1888. The recipients of these grants, who we call National Geographic Explorers, are a diverse community of changemakers from around the world (140 countries and counting!) working to support our mission to illuminate and protect the wonder of our world.

Explorers are the heart of the National Geographic Society. The National Geographic Society's Grants Program provides seed funding and support to early career individuals and more senior scientists who are working to address critical challenges, advance new solutions, and inspire positive transformation across all seven continents. The featured Explorers in this program—who I am excited for you to meet—received grants for biological science projects focused on research, conservation, or technology and aligned with one of the Society's focus areas: Ocean, Land, Wildlife, and Human Ingenuity. In this program, you'll learn that National Geographic Explorers are infinitely curious people who are passionate about our planet and making it a better place.

The National Geographic Society has a rich legacy of supporting biology and those studying Earth's living

organisms. Some of our Explorers are iconic, like Jane Goodall and Jacques Cousteau, both of whom the Society supported in their earliest fieldwork before they were household names. Other Explorers you may not have heard of, but they are pushing the boundaries of botany, conservation, ecology, evolution, genetics, marine biology, microbiology, and physiology. I became an Explorer in 2007 when I was awarded a National Geographic Society grant to study the feeding ecology and adaptation of Delacour's langurs (*Trachypithecus delacouri*), a type of monkey living on rugged limestone karst mountains in northern Vietnam. My project investigated several hypotheses to explain the langurs' distribution on the karst. The grant funds paid for the analysis of soil and leaf samples that the monkeys ate, allowing me to better understand the chemical and nutritional ecology of their diet. Over the course of this series, you'll meet other Explorers and learn how their work is helping us to better understand our planet and also make it a better place.

THE BIOLOGY EXPLORER VIDEO SERIES

The *Explorers at Work* video series for this program helps set the stage for the concepts presented throughout the textbook. These videos, which I had the opportunity to host, illustrate key concepts for biology and touch on themes and ideas from several units. Due to COVID-19 travel and safety restrictions, each of the five units includes a *virtual* visit to the Explorers' fieldwork and lab locations around the world. The video series serves as a guide connecting the concepts in this program. Plus, it's a wonderful chance to hear firsthand from some of biology's most innovative and intrepid scientists.

For Unit 1, which focuses on interactions and relationships in ecosystems, Explorer and marine biologist Dr. Diva Amon takes us deep beneath the ocean to ecosystems and organisms that few people have seen firsthand. We cover topics such as how matter is transferred and energy flows in deep-sea ecosystems, how organisms interact in the deep sea, and how human activities disrupt deep-sea ecosystems. Amon describes what it's like to work nearly two miles beneath the surface of the ocean and her research methods, including the submersible in which she travels to the oceans' depths. She also shares

what she has learned about deep-sea ecosystems and the unusual creatures that live there, as well as what sparked her original interest in marine biology.

In Unit 2, we cover cell systems and the important role of bacteria in our intestines. Explorer Dr. Katie Amato discusses the importance of the gut microbiome on human health, how some bacteria in the gut can destroy toxins and also supply essential nutrients that humans cannot make themselves, such as vitamin K. Drawing upon her research studying the gut microbiome of wild howler monkeys and baboons, Dr. Amato draws connections between human cells (such as intestinal cells), nutrition, and gut bacteria and describes how environmental factors and dietary changes affect the growth and composition of gut bacteria in both monkeys and humans. The interview wraps with Dr. Amato offering advice to high school students who are interested in becoming a microbiologist or other type of biologist.

Unit 3 takes us on a journey to a protected area of the Amazon rainforest in southeastern Peru, one of the most biologically diverse places on Earth where the treetop canopy reaches over 60 meters (200 ft.) high. Explorer Dr. Varun Swamy talks about the interconnectedness of organisms in tropical rainforests, specifically his research on plant-animal interactions and the processes by which tree diversity and regeneration are maintained in this ecosystem. Dr. Swamy explains how mammals like spider monkeys support tree diversity by spreading seeds far away from parent plants, how the use of drones and citizen scientists help him and his team to collect and analyze large amounts of rainforest canopy data, and the role of DNA barcoding in his work.

In Unit 4, the video explores how genetics can track the spread of viruses by using one of the most blood-curdling examples: vampire bats! Explorer and infectious disease ecologist Dr. Daniel Streicker takes us to the mountains of Peru where he researches how bat and human communities are regularly affected by rabies, a deadly disease that's incurable once symptoms take hold. Rabies is an example of a zoonotic pathogen, a disease-causing germ that spreads between animals and people. Dr. Streicker uses genetics from bat blood samples to learn how rabies spreads through the population. This was perhaps the most timely interview, as we talked about how his research can be applied to the COVID-19 pandemic—and to future pandemics.

Finally, in Unit 5 we explore how hummingbirds adapt to their environments, from the Andean highlands of Ecuador to the deserts of Arizona. Explorer Dr. Anusha Shankar explains why hummingbirds make such great subjects for studying topics such as metabolism, energy conservation, and bioenergetics, as well as torpor, which is when animals decrease their physiological activity by lowering their body temperature and metabolism. She also describes the role of genetics in hummingbirds' ability to fine-tune their energy expenditure and daily torpor. We learn that hummingbirds are evolutionarily adapted to survive in different environments, and climate change and other human-caused environmental changes might impact hummingbirds' energy budgets.

Our planet is teeming with complex and fascinating biological organisms, from microbes to green-blooded lizards to blood-sucking vampire bats to our own human species. Throughout this program, our aim is to sharpen students' analytical skills with exciting and interactive case studies so that they not only succeed in Biology but also become inspired to use these tools throughout their lives to better understand the world around them, their place in it, and how they can contribute to a more livable and sustainable world for all living creatures. Let's go!

National Geographic's Catherine Workman and Dr. Anusha Shankar discuss Shankar's research on daily torpor in hummingbirds.

