WOMEN IN SCIENCE

forging new pathways in green science

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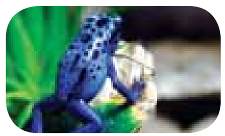
16  SUSTAINABILITY
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Going Green to Save the World

We hear all the time these days, in the newspapers and on TV, about the terrible global problems like famine, drought, climate change, and disease epidemics. Sometimes, these problems seem so big that solving them appears hopeless. But there are many scientists—including the extraordinary women featured in this booklet—whose passion for discovery and compassion for our planet and its peoples, fuels their search for answers to these difficult issues. Here, these women share their wonderful stories of working in "Green Science," showing us how they bring their unique combination of enthusiasm for science and concern for others together to make the world a better place.

Research in Green Science looks for new ways to help people around the world, particularly in developing countries, lead more productive and sustainable lives. For example, Karin Jacobs is working to understand the unique bacteria that are needed to sustain the local plants around Cape Town in South Africa, while Nani Drame is using modern molecular biology techniques to help farmers in Africa grow more drought-resistant crops. Often working under difficult conditions, all of the motivated and inspiring women featured here have already made a difference and improved the lives of many people through their research. They are helping to reduce hunger by finding means of growing foods more efficiently while using fewer resources, they are improving local economies by turning native plants into products that can be sold, and they are finding natural sources for new medicines by testing plants for their therapeutic potential.

Their stories of difficulties and sacrifice, of success and adventure, are all real. Some have struggled through poverty; others have overcome discrimination or the challenges of raising a family while still doing top quality research. We hope that the passion and compassion that these women demonstrate in the way they live and work will inspire others to follow their lead, finding new ways to help the planet and *all* of its inhabitants.

Sean Sanders, Ph.D.
Commercial Editor, *Science*

Changing the Face of Science

The L'Oréal-UNESCO Partnership For Women in Science

For the past thirteen years, L'Oréal and UNESCO have taken the initiative in recognizing women whose research contributes to changing the world. These top-ranking scientists embrace universal challenges ranging from health and the environment to social actions, and represent the key to the future.

Yet the role of women in science still needs to be defended. At the global level, women hold over half of university degrees, but only 30 percent are in the sciences or technology. In the United States, a recent study by the Center for American Progress shows that a woman scientist with a Ph.D., married with children, has a 35 percent lower chance of being granted tenure than a man with the same family situation.

Paradoxically, according to a 2009 TNS Sofres survey conducted in 10 countries in partnership with the L'Oréal Corporate Foundation and UNESCO, 84 percent of respondents believe that science lies at the heart of their daily life.

Through the For Women in Science program, L'Oréal and UNESCO work together to promote the cause of women in science by highlighting scientific excellence and encouraging young women to pursue scientific careers.

- Each year, 5 eminent women scientists are honored by the L'Oréal-UNESCO Awards, one per continent, for their outstanding scientific contributions and commitment to research.
- Each year, Fellowships are awarded to promising young women to encourage them to pursue careers in science.
- During the past thirteen years, nearly 1,100 women have been recognized: 67 "For Women in Science" Award Laureates from 30 countries; over 1,000 Fellowships for young women researchers in 98 countries.

For many young researchers, the program today represents an invaluable source of motivation and inspiration.

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ALEJANDRA BRAVO

Environmental Responsibility: Protecting Native Lands

When **Dilfuza Egamberdiyeva** realized the devastating toll that many years of toxic pesticide use had taken on her native country, Uzbekistan, she had to do something. Under Soviet rule, Uzbekistan kept cotton production high through the use of harmful and toxic chemicals that now contaminate about 90 percent of Uzbekistan's land and water—and cause chronic renal and lung disease in Uzbek children living in these regions. Additionally, cotton's thirst for water left high salt levels in the soil from over-irrigation.


DILFUZA EGAMBERDIYEVA

A mother herself, Dilfuza knew there had to be a better way to produce healthier fruits and vegetables using biological, not chemical, fertilizers and fungicides. Microbes were the key. During the last 10 years, she successfully patented a microbial product. The bio-fertilizer contains beneficial bacteria able to stimulate plant growth, control tomato and cucumber diseases, and enhance the nitrogen and phosphorous levels often lacking in salty soils. The product is used on agricultural lands growing cotton, wheat, and vegetables throughout the country.

Dilfuza says her high-profile work led to international recognition including the UNESCO-L'Oréal fellowship. The recognition not only helped her establish research networks, she was also asked to work with the country's international relations department, representing her country at global conferences. "I'm happy the world knows about the science going on in Uzbekistan," she says

L'Oréal-UNESCO Awards often offer scientists a platform to raise important issues—such as the increasing need to find substitutes for toxic agricultural chemicals. One Award laureate, **Alejandra Bravo,** a molecular microbiologist at the National Autonomous University of Mexico in Cuernavaca, has harnessed the natural pesticide produced by an insect-killing bacteria called *Bacillus thuringiensis,* to protect Mexico's vast corn crops—without harming the environment. By inserting certain genes from the bacteria, nicknamed Bt, into corn DNA, the plant can produce its own personal pesticide, which is non-toxic to other organisms and degrades completely in the environment.


SARRAH BEN M'BAREK

The only problem is that insects can evolve resistance to Bt. But Alejandra uses her collection of 8000 different Bt bacteria from soils across her country to keep crops one step ahead of insects. Once she figured out how Bt kills insects, Alejandra used that information to develop modified Bt toxins that would render insects defenseless.

More recently, Alejandra has found that the Bt toxins can safely and effectively control mosquitoes that transmit devastating human diseases such as malaria and dengue fever—diseases that have usually been controlled by toxic chemicals. Alejandra's enthusiasm is, itself, infectious. "Science keeps you alive—because you are always thinking and learning, identifying the next question to ask," she says.

Scientists, like Dilfuza and Alejandra, are a unique breed: women using science to protect their native lands.

CROSSING CULTURES, BUILDING BRIDGES

Sarrah Ben M'Barek is using her cross-cultural research experience to build bridges between countries. Born in Tunisia, Sarrah would travel often to visit her mother's family located near one of the oldest tree cultivation centers in the Netherlands. As a child, traversing between tree nurseries in Boskoop, The Netherlands, and wheat fields in Beja, Tunisia, plant biology ran through Sarrah's veins, as did a growing desire to protect one of the world's most important crops, wheat, from disease.

What is Environmental Responsibility?

Environmental Responsibility loosely defines scientific strategies to improve the responsible use or protection of our environment. Environmental researchers monitor the planet—in both its clean and polluted states—to find ways to reduce growing human impact on ecosystems. Over land and in the sea, the world's resources are increasingly scarce or threatened. Therefore, finding new ways to make efficient use of resources—soil nutrients, water, or fish—is considered the key to living in a sustainable way.

Sarrah is something of a detective. "What excites me is using science to uncover the interaction between the host and the pathogen," she says. A current UNESCO-L'Oréal fellow, Sarrah dedicated her Ph.D., conducted at Plant Research International & Wageningen Research Center in The Netherlands, to investigating the genome of a killer fungus, *Mycosphaerella graminicola,* a disease so devastating that $600 million is spent each year in Europe alone to apply fungicides to prevent the annual 15–50 percent yield losses.

Sarrah wants to find the genes that make this fungus so harmful—clues that will lead to more sustainable ways to keep the fungus at bay. As she looks for signs of the fungus' weaknesses in its DNA, she hopes to follow in Dilfuza and Alejandra's footsteps—decreasing the use of fungicides by finding other ways to control disease.

Sarrah wants to take advantage of her unique position, straddling two countries and fluent in four languages, to encourage student exchanges between Tunisia and the Netherlands. "I want to keep this connection alive between one of the world's most important wheat producing regions and one of the world's most important agricultural universities," says Sarrah.

These passionate scientists are able to use their research to build bridges between countries, or even continents. Following her successful postdoctoral research at the University of Waterloo in Canada, **Laura Echarte** has built a long-term series of experiments that provide opportunities for young researchers in her native Argentina. Now a crop physiologist at the National Research Council of Argentina in Balcarce,


LAURE ECHARTE

Laura is collaborating with Canadian coworkers to determine which farming system uses resources most efficiently.

For example, Laura, a UNESCO-L'Oréal fellow, has found that planting maize together with soybeans is a good combination. Soybeans, traditionally intensively cropped in Argentina, take nitrogen from the air and "fix" it in the soil, but they also use up many other important nutrients, systematically reducing soil fertility. However, maize produces tall stalks that, when they decompose, return to soil those nutrients stripped out by soybeans. Grown together, the crops maintain a healthy balance of soil nutrients. "I want to help farmers decrease the gap between potential and actual yield," Laura says. She is taking the research one step further by finding ways to improve soil conservation and reduce greenhouse gas emissions. "The magnitude of the problems we face is great, and I hope women, who are often drawn to environmental science, understand the opportunities that exist," Laura says.

And there are opportunities everywhere. Some scientists are urgently trying to retrieve valuable biological specimens from the last untouched places on Earth—before it's too late.


KARIN JACOBS

DOCUMENTING THE WILD

Understanding how limited water and nutrients leads to unusually high plant diversity in a small belt of *fynbos,* or shrubland, in the Western Cape of South Africa is what drives **Karin Jacobs'** research. Even though water is scarce, over 9,000 plant species live here—two-thirds of which grow nowhere else in the world. Karin, trained as a fungal taxonomist, has found that the microbes in the soil are as unique and diverse as the plants above. "Anything that disturbs the plant diversity disturbs the microbes," she says. Yet it is the microbes that control the nutrients that the plants need.

Karin was drawn to the arid, low nutrient soils, in part, because she wanted to understand how such low fertility soils support such a diverse plant community. She's come to realize that it may be because the ice ages that devastated species diversity in northern hemispheres never occurred here. Unfortunately, only a few stretches of the fragile fynbos ecology remain intact; many are the focus of conservation efforts. Karin is investigating how important the microbes are to recovering the ecological processes that occur in these regions.

Karin is using new molecular tools to explore this underground world. Most soil microbes can't yet be grown in a laboratory, so they remain a mystery. Using molecular fingerprinting techniques, Karin is able to determine which of these tiny organisms are simply present and which are key to cycling nutrients. "So far we've only seen and described a fraction of the microbes on Earth," she says. As she wades through the mountain of data that come from microbial DNA profiles, Karin says the UNESCO-L'Oréal fellowship gave her the confidence that, in the male-dominated world of science in South Africa, she was pursuing important questions. "In the end, hard work and good ideas are rewarded—no matter one's gender."


LINA SAAVEDRA DIAZ

Lina Saavedra Diaz is working on a plan to quell the chaos that threatens another male-dominated world—that of small-scale fishers in her native country, Colombia. She says overfishing will continue to deplete Colombia's fisheries resources until the country comes up with a fisheries management plan. Without better regulation, she says, fishermen's livelihoods are in jeopardy. "It's a mess. It's open disorder because anyone can fish whatever they want, however they want, without supervision," she says.

Lina has interviewed 300 fishermen and fisheries experts in nine fishing communities on both the Atlantic and Pacific coasts of Colombia. Her goal? Giving the fishermen a voice and at the same time providing her government the fishing records and economic data it needs to take the first steps towards creating a fisheries management plan.

Lina agrees that winning the UNESCO-L'Oréal fellowship builds confidence—confidence she needed when she felt overwhelmed by the duty entrusted to her by these fishermen. "When I started, this was just a research project. Now I feel like it is a life project," she says. "The fellowship gave me the strength and hope to believe in my dream to help bring order to the seas in my country," she says.

JOANNE CHORY

Biotechnology: Giving Nature a Helping Hand

Joanne Chory was innocently studying microbiology when science made a celebrity of a delicate little weed, causing her interest in plants to bloom. The weed was *Arabidopsis thaliana* and it was the first plant to have bits of its DNA, and eventually its entire genome, sequenced. But the real breakthrough occurred when scientists successfully introduced genes from other organisms into the weed's cells. It is called plant transformation and it, literally, transformed Chory's research career—offering endless opportunities of exploration. "I wanted to understand complex biological systems, and I got in on the ground floor of plant biotechnology at the dawn of the molecular age," she says.

Twenty years and a revolution in biology later, Joanne, now a plant molecular biologist at the Salk Institute in San Diego, California, continues to explore one fundamental question—how do plants respond to changing environmental conditions. "Plants, unlike animals, can't walk into a building to get out of the cold—yet the same plant can respond differently depending on where it is stuck in the ground," she says.


MARIETTA SOLANGE SOUPI NKEUTCHA

Joanne made a pivotal discovery while examining the genes of *Arabidopsis*. She found—to the surprise of many—that plants actually make hormones, similar to the male or female sex hormones found in humans, that regulate the plant's size. "No one thought plants had the same sort of systems as humans to beef themselves up," Joanne says. The discovery was exciting because it offered a potential way to make plants larger and more fruitful. "I didn't sleep the night after we got our results," she says.

Joanne's work—which combines genetics and biochemical techniques—highlights how biotechnology spans disciplines and at the same time shrinks the divisions between them. Increasingly, her research has a more practical purpose—determining how plants might better tolerate and adapt to the stresses associated with climate change.


NANI DRAME

The pressures on the planet are increasing dramatically. By 2050, there may not be enough food to feed a population of 9 billion people because there will be less arable land and not enough fresh water for irrigation. Scientists are working hard to find ways to not only increase crop yields, but to do so with less impact on the environment—pressures that are fueling new opportunities to "green" agriculture.

For Joanne, the environmental pressures become personal. "My work is increasingly motivated by the concerns over what kind of world we are leaving our children and grandchildren," she says. Not surprisingly, Joanne is one of many L'Oréal-UNESCO Award winners turning to plant biotechnology to—sustainably—produce more food.

REGIONAL ROOTS

More recently, UNESCO-L'Oréal fellows from Africa, such as **Marietta Solange Soupi Nkeutcha** of Cameroon and **Nani Drame** of Senegal, have turned to biotechnology to improve agricultural yields in their own regions. In Marietta's case, her work will directly improve her family's cocoa plantation—not to mention the world's supply of chocolate. Cocoa seeds are used to make chocolates as well as cocoa butter. But cocoa growers in some tropical African countries, such as Ghana and Cameroon, have struggled with low yields in recent years—due to low soil fertility and plant disease.

What is Biotechnology?

Biotechnology describes the intersection of biology and technology. Throughout history, humans have changed living creatures to suit their purposes; for example, by domesticating animals or cultivating plants. Biotechnology uses a modern set of molecular tools that allow scientists to change an organism's DNA to produce, for example, new crops or medicines. This process of "genetic engineering" has allowed researchers to transfer specific pieces of DNA between different organisms in order to produce new products or abilities.

The UNESCO-L'Oréal fellowship funded Marietta's Ph.D. research to use biotechnological tools to get more high-yielding plants into farmer's hands. Working at the University of Limoges in France, Marietta is developing a way to harvest embryos from plant tissue, such as flower buds, and grow them in glass Petri dishes in her laboratory. As a result, she can quickly turn a small amount of plant tissue into a large number of identical plants ready for planting.

Nani Drame has a similar drive to improve her region's farming capacity. After finishing her Ph.D. studying plant tolerance to drought at University of Paris XII in France, Nani contacted the African Rice Center in Benin, a pan-African research organization devoted to improving food security in Africa. Nani wanted to apply her skills in molecular biology to help make African crops more tolerant to drought. The African Rice Center had no funding to hire her at that moment, but encouraged her to apply for the UNESCO-L'Oréal fellowship—which she won, and immediately began working to combine the drought tolerance of African rice with the high yield potential of Asian rice. She made progress identifying potential sources of drought tolerance genes

JENNIFER THOMSON

and assessing the genetic diversity of African varieties before an even more dire problem—how to improve plant yields in toxic, iron-rich soils—caught her attention.

The reddish water that flows from flooded rice fields is an all too common sign of the toxic levels of iron in the soil that plagues the lowlands of West Africa. Most farmers, Nani says, abandon these fields when yields decline due to the high iron content. Nani is using biotechnology to identify which genes control a plant's response to iron toxicity and then using that information to breed new varieties that are more tolerant of iron. "With agricultural research, we can improve a country's health and wealth at the same time," says Nani.

TACKLING CONTROVERSY

Before Marietta or Nani had even begun their work, **Jennifer Thomson,** a plant geneticist at the University of Cape Town in South Africa, was already blazing a genetic engineering trail to improve crop yields. "I'm a passionate African, and I realized that people just simply don't have enough to eat," she says of her motivation. She set her sights on South Africa's biggest viral scourge—the maize streak virus, the crop's number one killer. It took almost a decade, but her efforts paid off. In 2007, she introduced the first transgenic maize variety resistant to the maize streak virus.

As biotechnology breakthroughs increased, so did the controversy generated by the techniques. Jennifer experienced both the ups and the downs. Genetic engineering, particularly transgenics—techniques used to take genes from one species to another—is widely considered a safe method to produce pharmaceutical drugs or new crop varieties. But its use has prompted concerns that the resulting transgenic organisms may have unintended effects on the environment. For example, transgenic crops could become weeds in the wild or introduce new allergens into the food supply.

Jennifer hopes that anti-genetic engineering sentiments, which have slowed other scientists' research at times by, for example, delaying government approval of field trials, won't impact her future endeavors. The L'Oréal-UNESCO Award laureate has used her notoriety to debate the scientific merits of the techniques. It may take time, but Jennifer says a rational assessment of the science will validate genetic engineering's potential. Her advice for young researchers is simple: Don't pretend genetic engineering is a magic bullet. It isn't. But it can solve certain immediate problems.

With the growing number of climate change-induced agricultural problems, biotechnology can be used to address many such issues, including the need for more drought-tolerant crops. Jennifer's students have found genes that reduce water loss in a so-called resurrection plant, a mountain-top flowering species able to withstand extended periods of drought and rehydrate completely in a fresh rain. They are now investigating how to introduce these genes into maize varieties hard-hit by drought stress. "It's been so exciting to see the next generation of researchers take the technology and fly with it," she says.

Half a world away, another UNESCO-L'Oréal fellow, **Analilia Arroyo Becerra,** a plant geneticist at the Research Center of Applied Biotechnology in Tlaxcala, Mexico, is also exploring the genetics of recently discovered Mexican varieties of resurrection plants in the hopes of one day improving maize's drought tolerance. Working with her husband and research partner, Analilia is beginning the first molecular studies of them; looking for any master genes that

ANALILIA ARROYO BECERRA

enable these plant cells to survive drought and other stresses.

Anti-genetic engineering sentiments have been strong in Mexico, where the domestication of maize began roughly 10,000 years ago. The government has, until recently, maintained a strict policy banning transgenic crops for fear they would contaminate the thousands of local maize varieties. Analilia says the controversy over transgenics inadvertently drew her to the field because she wanted to understand how plants' natural processes differed from biotechnology-enhanced ones. She realized that transgenic techniques may in fact be a safer way to improve crops than the more accepted method of creating hybrids. "Hybrids are a mix of the thousands and thousands of genes from the different complete genomes of two plants, but with biotechnology we can put just one gene into a different species and carefully analyze how those plants perform," she says. It is with great care that Analilia hopes to improve the production of crops in her country.

These researchers all demonstrate that biotechnology can improve the world's dwindling food supplies. They do so by sharing one passion in common—a deep and abiding desire to help feed the world, sustainably. "When scientists explore research they are passionate about, they do their best work and create even more exciting opportunities," says Jennifer.


VENETIA BRIGGS

Biodiversity: Saving Life's Vast Varieties

Every week, **Venetia Briggs'** parents, both orchid enthusiasts, took their children into Belize's jungle to see the plants. By 17, Venetia was teaching foreign students about tropical forests. She launched her science career with a job at the Belize Zoo.

She's had many female role models—her mother, grandmother, college zoology teacher, first graduate advisor, and "excellent women biologists from all over the world"—during her Ph.D. studies at the University of Miami.


VENETIA BRIGGS

Specializing in animal communication, Venetia researched red-eyed tree frog 'dating.' "They use visual, acoustic, and even vibrating signals to attract a mate," she reports. Venetia studied them at the Smithsonian Tropical Research Institute in Panama. "My work was super-exciting, very cool. The project was so unique, I'd go out in the field at night, working on my own. The frogs were models for questions I needed to answer. They opened all kinds of doors for me."

One door led to a bigger animal. Venetia is Belize's first official Wildlife Ecologist. She splits her time between her employer, the University of Florida Research and Education Center, and her field site in Belize. Venetia co-directs a research station with an ambitious community-based conservation project for Belize's endangered jaguars. By using camera traps to track jaguars' movements, "we hope to provide information to landowners that value 'big cats' on their property, and economic incentives for land use that protects the jaguars," explains Venetia, who's often in the jungle placing and monitoring cameras. Her team involves the community in landscape conservation and potential tourism resulting from jaguar research.


MAJA ZAGMAJSTER

"I live out of a suitcase," Venetia admits, "with six addresses in four countries since completing my Ph.D. You have to really love it, or it gets tiring. But I'd be completely bored in an office. I need the outside! I'm happiest in the jungle, in the middle of nowhere. It's so beautiful."

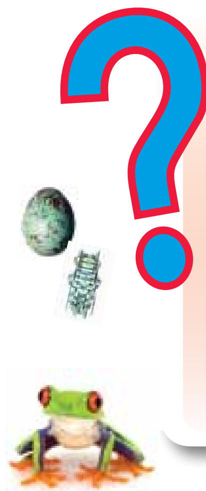
Trying to maintain a social life makes "coming home to my family a top priority." Venetia's brother in California is her biostatistician. "It gives us more time together. In the middle of the jungle, I pull out my laptop and we discuss the numbers."

At conferences, Venetia, a UNESCO-L'Oréal fellow, is pleased to hear professors say that young women are taking over Ecology. "I got paid to play with tadpoles and frogs. Now I get paid to run with phantom jaguars in the jungle, and teach the next generation. I'm so excited to be home in Belize. This is my complete dream job," Venetia declares.

EXPLORING DEEP DOWN

Maja Zagmajster's dream job has a different setting: underground caves. "I blame it on the bats," she announces. While she was studying zoology at her home university in Ljubljana, Slovenia, finding a live bat lying on a street aroused her curiosity. "I did some research and discovered bats are very fascinating—and one of the world's most endangered mammals." Maja found some professors and students already studying bats. Together they organized the Slovenian Association for Bat Research and Conservation. "If you start a society, you'll meet people who share the interest, and can apply for research funds," notes Maja, who was society president for ten years.

For their first international study project, Maja visited caves where bats roost in winter. To explore more challenging caves, she had to learn rope-climbing. Special gear, including helmets, overalls and lights, is required. "Caving is very popular, combining sport, research, fun, and social activity," says Maja. "Visits are always in a group, for safety."



What is Biodiversity?

The richness of life on earth evolved over billions of years and includes millions of species, from tiny bacteria to giant trees. "Biodiversity" describes the differences among these species and changes depending on where you are on the earth, like a tropical rainforest or the North Pole. Conservation biologists use biodiversity to measure the health of a particular ecosystem—a loss of biodiversity often indicates a problem. They focus on finding ways to preserve and protect biodiversity. This includes reducing or preventing the effects of threats like pollution and climate change, or the problems caused when humans move into previously uninhabited areas.

She specialized in biodiversity of cave animals for her Ph.D. at the University of Ljubljana. "I learned new tools and techniques for analyzing the distribution of animals. My region of research, the Western Balkans, is a world hotspot in subterranean biodiversity, with about 1,000 species that live only in caves." Maja hopes to help preserve them.

Caves require different amounts of exploration time, varying with size and depth. Maja, a UNESCO-L'Oréal fellow, has gone as deep as 180 meters in one vertical drop to enter a cave. "Underground, you can't explore quickly. When you come out, it doesn't feel like you were in a cave for eight hours or even more." Just during the summer of 2009, Maja visited 20 caves. "They're an unusual, challenging, exciting environment. With our studies, we answer difficult questions spanning many species, not just cave animals."

European caves are the world's best-studied. "In the 16th century, people thought dragons lived in them! Real cave animals weren't discovered until the 19th century, first in Slovenia," explains Maja, now a researcher who also teaches undergraduates at the University of Ljubljana. "I'm so lucky to be able to do this as my full-time job."

MARIA GABRIELA GEI

SAVING A FOREST

Unlike Maja, **Maria Gabriela ("Maga") Gei** works high above the ground, studying trees. Maga always excelled in math, but disliked her Electrical Engineering studies at the University of Costa Rica. Then she met a group of forest conservation students who were educating people on the Caribbean coast about how an oil company's explorations there would harm the environment.

"I decided to switch to Biology, and got to know my country on field trips to places I'd never been," Maga remembers. For graduate studies, eager to remain connected to her homeland, she chose a University of Minnesota program that lets her continue research in the tropics, while teaching general biology to undergraduates. So far, her five-year program is very gratifying, even while "surviving two tough Minnesota winters."

In September 2010, she moved to the Guanacasta Conservation Area (GCA), one of Costa Rica's last remaining dry forests. "In areas with nice climate, 97 percent of original forest was cleared for human settlements, agriculture, and ranching," explains Maga, who's relieved that some regeneration is occurring. "Thanks to my UNESCO-L'Oréal fellowship, I have more time for research and field work, and can pay for my experiments. I go to GCA on short trips to develop my project: studying a group of trees involved in the important nitrogen cycle, which is being altered by humans."

Maga's research goal is showing why the remaining forests are vital. "It's tempting to stay here and have the resources to continue doing research, but I want to return to Costa Rica and be part of rescuing forest ecosystem services. And I hope to have volunteers from my college."

She loves her flexible schedule, the chance to be outdoors enjoying nature, and her program's excellent teamwork. "These days, it's teams that do the research. You have to exchange ideas. My program is demanding and multifaceted. I've had to learn computers and chemistry, and will learn a lot more in the field."

To Maga, "Anybody who applies creativity and enthusiasm is able to do great science. It requires a lot of observation, but it's very rewarding. I think we are responsible for keeping the earth's beautiful things around for future generations. I want to help do that."

THE LURE OF THE SEA

The oceans are **Giovanna Sotil**'s inspiration and research setting. As a teenager in Lima, Peru, a television program about molecular biology in France inspired her to start reading about genetics.

In high school, "most of my teachers were nuns. One loved animals, and kept fish in the classroom. Another was a former marine biologist," Giovanna remembers. At Universidad Nacional Mayor de San Marcos, she studied biology, working with geneticists.

When she was ready to start a Ph.D. program, "I had no travel money for the places where I wanted to study phylogenetics." She's grateful for the UNESCO-L'Oréal, Andrew Mellon, and EU-Censor fellowships that allowed her to study in Panama, France, Texas, and Florida, and work closely with her advisor at Lousiana State University. "To see how environmental factors affect biodiversity, I study how a certain marine snail, living in both the Atlantic and Pacific Oceans, adapts to environmental changes, like shifts in water temperature. We use genetic, molecular, or biochemical tools. In some widely-separated places, the snails have developed very different ways of dealing with the changes. It's awesome."

GIOVANNA SOTIL

"We always hear the music of the waves. I care about letting people know what we have—and how we can protect it."

As Professor of Biological Sciences at Universidad Nacional, Giovanna enjoys teaching future biologists. "They all know all about Ricky Martin! But they don't know why biologists are so in love with their careers. To be in science, it's not for the money. It's the excitement of learning new things all the time. For every question, when you answer it, you have not one fact, not two, but thousands! And it's never-ending," she says enthusiastically.

Once, Giovanna had "a professor who would take us to the beach and teach us diversity by explaining different organisms. It amazed me." Now, on the beach, Giovanna teaches her nine-year-old nephew "why this animal is here, or how that plant is different. I let him watch me do very simple experments there. I know that can make a child curious, and build interest about nature and a love of biology," she observes. Living on Peru's coast, "We always hear the music of the waves. I care about letting people know what we have—and how we can protect it."

Sustainability: Sustaining the World's Organisms

At first, **Adriana Jalba** wanted to be an artist. Growing up in the Romanian countryside as a forest ranger's daughter brought constant contact with nature. "My excellent biology and botany teachers influenced me, too," Adriana remembers. By age 18, she recognized her passion for biology. She did become an 'artist'—with plants.

In her first job, research assistant at Bucharest Institute of Biology, Adriana gravitated towards conservation projects. Finding research funding in Romania was difficult. "I wanted to do new things, so I searched for a grant in Europe." In 2003, she received a UNESCO-L'Oréal fellowship and a grant from Denmark's National Environmental Institute, to study effects of environmental stress on thyme.

For her Botany Ph.D., specializing in rare species' environmental issues, Adriana accepted a fellowship to the University of Brussels in 2004, the year she was married. Her daughter was born in 2010. "Juggling family and work is sometimes difficult," admits Adriana. She's grateful for her husband's constant support, "even helping me at the university with experiments and equipment." In 2010, when she completed her degree, he joked, "They should give me a Ph.D. also—I know all about your work!"

By 2007, Adriana realized, "I didn't want to spend so much time in the lab anymore. I decided to look for a private sector job." She's now an Environmental Health and Safety specialist for Huntsman, an international chemical company. "I have great responsibility about the safety of our products. It's very important to me that my company complies with all regulations, and that people are safer because I do a good job, with real impact on lives."

Adriana encourages young women to consider science as a career. "If you want to change direction in your field, it's easier than in other jobs. It's really exciting and stimulating—every day you're doing something else."

She enjoys working in both English and French, at an international company. As a researcher, "Sometimes I didn't even get to wear my dresses or good shoes—just always jeans and lab coats." The private sector pays better than universities, she adds. Adriana loves living in Brussels. With its vibrant international community, "I meet people from all over the world. It's terrific. We get great food …. and the best chocolates."

SOLVING WATER PROBLEMS

Meals matter to **Melodie Naja,** too. "At our family dinners, conversations get complicated," confides Melodie, whose four sisters are also Ph.D. scientists. Growing up in Lebanon, constantly asking questions about nature, she decided to find answers herself.

With her Environmental Physical Chemistry doctorate, from Université Henri Poincaré in France, Melodie worked for the Lebanese University for two years. "It was very hard. With no research funds, you had to fight for equipment and tools." Determined to be a researcher, she's since worked in Canada, Singapore, and France, before settling down in the United States. "I call myself a Scientist Without Borders," Melodie jokes. "Each time, I tackle different problems. I helped a French mining company reduce pollution from heavy metals." As a UNESCO-L'Oréal fellow in Canada and at Singapore's National University, she pioneered the use of algae in decreasing pollution.

At McGill University in Montreal, she investigated how algae could combat water pollution. "It's hard for researchers to go from a lab to the business sector," Melodie observes. "After our pilot projects to develop a commercial product using algae, we set up a small company. It's been fascinating."

While at McGill, Melodie visited Everglades National Park in Florida. "I loved it, and it made me realize that I was ready for bigger challenges." In 2008, she joined the Everglades Foundation as a Water Quality Scientist. She collaborates with Florida International University to detect Everglades' pollution levels through nanotechnology. "The Everglades became the world's

What is Sustainability?

The practice of sustainability protects a plant or animal species, by trying to maintain its environment and the natural resources it needs for long-term survival. Keeping all sorts of different organisms healthy requires stabilizing the complex relationships among all living things, including humans. Sustainability science is quite a new field and brings together the biological, physical, and social sciences, from both local and global perspectives. Sustainability scientists build a dynamic bridge between knowledge and action, seeking practical solutions for important environmental problems, like pollution, water shortages, or endangered species.

biggest environmental laboratory. We're helping to develop stronger environmental regulations to clean up the entire ecosystem." Sometimes, Melodie even has to testify before judges about environmental issues.


EUGENIA DEL PINO VEINTIMILLA

With the Everglades Foundation, Melodie is developing fellowship and internship programs. "I get to teach young scientists eager to learn more about the Everglades. Recently, we organized special seminars for reports on our projects. The young girls in our program are brilliant, and so enthusiastic—that's what I love. It's not an easy path, but science is a fascinating field. Be passionate. Never give up," she advises them.

Happy on a small team (four scientists), Melodie is publishing more and becoming known for her Everglades expertise. She loves being outside in all of the National Park's different areas. "It's so exciting here! The Everglades is such a vast ecosytem, you can't control anything—it's just pure nature."

A LOVE OF THE LAB

Unlike Melodie, **Eugenia del Pino Veintimilla,** a L'Oréal-UNESCO Award laureate, prefers lab work. She entered Pontifical Catholic University (PUCE) in Quito, Ecuador without a specific study plan. The modern laboratory equipment of their impressive new Kennedy Science Program immediately aroused her curiosity.

"I don't like parasites or bacteria or dissecting. But two biology professors detected I was good in science, and encouraged me," Eugenia remembers. She also studied German, and soon faced a difficult decision, between a two-year language fellowship in Germany or four-year science fellowship in the United States. She chose science, and loved her graduate studies at Vassar College and Emory University. "Vassar also helped me to grow up; the cultural difference from Ecuador was very strong."

In 1972, her first (and only) teaching position, at PUCE, didn't provide research facilities. Eager to continue her research, Eugenia needed a local organism to study. In the university's garden, she quicky found an unusual species: a marsupial tree frog. The female has a pouch, like a backback, for carrying its babies. Studying the marsupial frog's unique biology became her lifelong research focus.

"In the U.S., I studied developmental biology and learned names of frogs from books. Back [home], I actually saw them. My horizons broadened," says Eugenia, professor of Biological Sciences. "When I started at PUCE, the combined study of evolutionary and developmental biology was new. Today, more scientists use this approach. It's now called 'Evo-Devo', and it helps build a greater understanding of evolution." Evo-Devo compares the long-term development of different plants and animals.

During her first year at PUCE, some of Eugenia's students joined the Charles Darwin Foundation for the Galapagos Islands to assist with research there. When they returned, Eugenia helped them analyze their data. "I guess I did a good job. The Darwin director suggested I come to the Galapagos, too." Since then, she's accompanied several students, guiding their field research.

The richness of Galapagos island life helped Eugenia appreciate nature's biodiversity. "I'm not a field biologist, but when I study a particular frog's early development, I realize that may be important for future conservation measures. Your work in science depends on you—you can decide what you want to learn. No matter what specific area a young scientist trains in, she may still be able to contribute to preserving our planet."

WORKING IN RURAL VILLAGES

"I don't discover—I research plants that were never studied before," declares **Gloria Montenegro,** who shares Eugenia's commitment to plant preservation. Half her research subjects grow only in Chile. "Although we have to harvest them in order to study them, we need to conserve and protect them."

As a child, Gloria loved climbing Chile's mountains, learning names of plants and animals she'd collect. Today, she and her students work closely with women in mountain villages. "We teach them to manage endangered plants to be sustainable—when to harvest, how much, best ways to pick plants, and how to air-dry to preserve chemical properties. Later we give them a diploma. It's very rewarding," says Gloria, professor of Agronomy and Forestry Science at Pontifical Catholic University in Santiago and a L'Oréal-UNESCO Award laureate. She also trains rural bee-keepers in pollination, and how to locate and protect their hives. "With my students, we do the basic science, publish the papers—but our relationship with the local people is what's very unique," she feels. The bee-keepers call her "The Queen Bee." Thanks to her discoveries, they export their honey and earn a living.

Gloria's patents include a honey-based natural fungicide she calls "safe enough to eat," and a medicinal plant extract that may help stop cancer cells from growing. She's proud to have over $1,500,000 in research grants, some specifically for developing products.

Now, Gloria tells young scientists, "Never forget the ethics and truth of science. Do it at the highest level. Try to do something for your own country." Back in 1970, starting a science career in Latin America was challenging. As the only woman in her university's Ecology Department, she fought for recognition. "Competition makes you stronger," affirms Gloria, who also had a young family then. "It helped that I married one of my professors. When I had to stay late in the lab, he understood. The issue is not to be the best at everything. It's to find your own comfort in dealing with it all. I need to feel passion for what I'm doing, and also have fun."

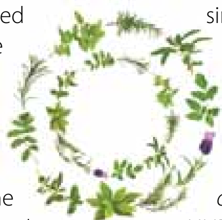
"With my students, we do the basic science, publish the papers—but our relationship with the local people is what's very unique."


GLORIA MONTENEGRO

AMEENAH GURIB-FAKIM

Medicines and Therapies: Green Gold

When **Ameenah Gurib-Fakim,** professor at the University of Mauritius, looks at her garden, she sees a common weed, *Centella asiatica,* which grows wild in her island country off the southeast coast of Africa. It reminds her why she started studying traditional medicine. "I am an organic chemist by training," she says, but after earning a Ph.D. in England and returning to Mauritius, she found it difficult to continue her research on the chemical synthesis of organic molecules, because her laboratories didn't have the right equipment. "So I started isolating organic molecules from plants," she says. "Then a colleague told me about medicinal plants. I realized that they are a goldmine!" She calls the study of traditional medicinal plants "my green gold." The little Centella weed in her garden is an example: it is studied as a possible therapy for skin diseases like leprosy, which is still found in many parts of the world.



Many modern medicines started as traditional treatments made from plants. Aspirin was discovered in a type of willow tree whose leaves and bark have been used for centuries for pain relief. But Ameenah says when she started working on traditional medicine in the early 1990s, it was considered "quackery." However, a few years later, health organizations like the National Institutes of Health in the United States began exploring alternative medicine, and "the European Union funded a major research initiative to document and study medicinal and aromatic plants," says Ameenah. "Naturally, I became involved and I've been cruising ever since!" She created the first full inventory of commonly used Mauritian medicinal plants—of which there are more than 600—and is publishing a similar catalog for Africa, the *African Herbal Pharmacopeia.* Ameenah, who is a L'Oréal-UNESCO Award laureate, continues to catalog the biodiversity of medical plants, saying, "Herbal medicine forms an important part of traditions and needs to be preserved so that future scientists can find new avenues for research." She also works locally to encourage women to cultivate medicinal plants. "Herbal medicine is here to stay," she says. "In the 1990's I was standing on top of a very small wave that is now a tsunami."

PRESERVING CULTURAL TRENDS

SUSANNA PHOBOO

Susanna Phoboo is also riding the green medicine wave. Like Ameenah, she studies medicinal plants, at Tribhuvan University in Nepal, where she is a graduate student. Her Ph.D. thesis work is on a plant called *Swertia chirayita,* which is used traditionally to treat a variety of diseases, from diabetes to fever. Susanna says the plant is reported to have many useful properties, including acting as an antioxidant, reducing inflammation, and preventing disease. She says it is also economically important, as "one of the most highly traded medicinal plants from Nepal, providing hundreds of rural Nepali households with an extra source of income." Susanna's work on medicinal plants even involves global climate change. She is interested in how plants react to changes in temperature or the amount of sunlight. These types of environmental stresses could change a plant's therapeutic properties, or could even cause it to become extinct.

Susanna, a UNESCO-L'Oréal fellow, views her work as both contributing to Nepalese health and preserving her culture. She says, "Traditional medicine is medical knowledge that is handed down from generation to generation and involves using local resources for prevention or healing of diseases and even for maintaining a healthy lifestyle. I have been fascinated with medicinal plants since I was a child, when my mother used them to treat my cuts, burns, fevers, and coughs." But although she values tradition, Susanna's research approach is completely 21st century. She says we must use science to overcome major challenges in traditional medicine, for example with experiments to see if and how traditional treatments work. We also need to make traditional treatments more like modern medicines, so we know how much medicine is in each pill, spoonful, or injection. Some traditional medicines are made by drying and crushing whole plants, or soaking them in water or alcohol to make an extract, so each batch can have different amounts of the useful ingredient. If we don't make sure the right plants are used, the treatments might even contain harmful substances. Susanna's use of modern science can help make traditional medicines more reliable.

What is Green Medicine?

Preserving biodiversity starts with cataloging a region's plants and their uses. Many plants around the world are used as traditional therapies for local diseases. Effective traditional treatments can provide a developing region with medicines that are locally produced and economically valuable. The women interviewed here are using modern technology to study traditional medicines, finding those that effectively treat or cure disease, and discovering how they work. They are also improving these treatments to best serve the needs of local communities in a "green" or sustainable way.

TEBELLO NYOKONG

LOCAL PLANTS, GLOBAL CURES

Using today's technology to study traditional healing methods is a common approach to green medicine—one that is also used by **Nonhlanhla Dlamini.** As a Ph.D. student at the University of KwaZulu-Natal in South Africa, Nonhlanhla was inspired by a talk on traditional medicines. "I later read that some African plants have led to production of successful drugs in first-world countries," she says. So why not use African plants to fight diseases in Africa? she thought. Her UNESCO-L'Oréal fellowship research project is studying African traditional medicinal plants to find drugs that are effective against Kaposi's sarcoma, a disease that causes mouth and skin lesions, and often occurs in AIDS patients. "In South Africa alone it can affect up to 40 percent of HIV-infected individuals. And currently there are no good treatments," says Nonhlanhla. She is searching for plant extracts that affect Kaposi's sarcoma cells grown in culture dishes, as a first step to finding new therapies.

Nonhlanhla sees great possibilities in traditional medicine, saying, "it has the potential to lead to the development of new, safe, effective and cheaper treatments. My desire is for traditional medicine to reach the same status and recognition enjoyed by Western medicine." Nonhlanha also just enjoys doing the science, especially interacting with people from around the world. "What I find the most exciting about my research is that it is multidisciplinary and I find myself collaborating with scientists and people from many different backgrounds."

PUTTING LIGHT TO WORK

Eight hundred kilometers to the southwest, Professor of Chemistry **Tebello Nyokong** also does science that is multidisciplinary, multinational, and locally focused, at Rhodes University in Grahamstown, South Africa. Tebello studies phthalocyanines, which are molecules that are chemically similar to the green chlorophyll of plants. Some are used as dyes for blue jeans. In Tebello's lab, though, they are being used as cancer therapies and to purify water.

When some phthalocyanines are exposed to light, they create chemicals called oxidants that damage cells, so new cancer therapies are being developed that send phthalocyanines into tumors, then trigger the release of their toxic chemicals with lasers. This treatment, called photodynamic therapy, specifically damages cancerous cells, so healthy cells are unharmed. But after photodynamic therapy, says Tebello, "the patient must be the in dark for several days. In Africa, we have a lot of sunlight, even indoors. So we need to design molecules that will work for phototherapy in Africa." For example, Tebello's researchers are trying to make the phthalocyanines more light sensitive—so that a lower dosage is needed—for use in African patients.

NONHLANHLA DLAMINI

"Everything in nature has a reason for being the way it is and scientists are just people who ask questions and want to know answers."

"We are also interested in the environment," says Tebello, "so we are developing fibers containing phthalocyanines for use in water purification." The oxidation reactions that are triggered when light hits phthalocyanines can be used to destroy water contaminants, too. "And the fibers can be reused, so they are environmentally friendly." She says she has lots of projects for interested young women. In her research, she works with physicists, chemists, and biologists, and her students come from as far away as France and China.

NATURE IS THE BEST TEACHER

The women interviewed here all say that green and sustainable medicine and therapy is a growing area, although they still have to fight stereotypes about women in science. But Tebello, a L'Oréal-UNESCO Award laureate, says that anyone like her, with a practical mind and a love of knowing how things work, shouldn't be discouraged, even if other people say science is hard, or only for boys. Nonhlanhla says to think about where you are headed, and have a plan to get there. "Get good grades, use the Internet to find scholarships in your fields of interest, enter scientific competitions and be part of scientific organizations in your schools. And writing is a big part of being a scientist, so sharpen your writing skills." Susanna advises staying alert. "Scientific research is fascinating but also frustrating. The results are not always what we expect. But some of the greatest discoveries in science were made by mistake or by coincidence, so a problem may become your greatest discovery."

Ameenah wants to encourage science teachers. "I was lucky to have enthusiastic teachers when I was a young girl interested in the sciences," she says. Although her school had little laboratory equipment, Ameenah said the natural world is a perfect science lab. As a student, she saw botany and ecology in action at a pond near the school and "learned physics from the colors of the rainbow!"

Susanna also learns directly from nature. As a plant scientist, she says, "Field study and nature walks are not only enjoyable and exciting, but also very educational. Everything in nature has a reason for being the way it is and scientists are just people who ask questions and want to know answers." So look closely at the plants you see everyday. They might contain a medical goldmine, just waiting to be discovered.

ADDITIONAL RESOURCES

www.aaas.org/programs/international/wist
AAAS Women's International Science homepage

www.agora.forwomeninscience.com/agora
AGORA forum for women in science—part of the L'Oréal-UNESCO partnership

www.aauw.org
American Association of University Women

www.awis.org
Association for Women in Science

www.braincake.org
Brain Cake: The Girls, Math & Science Partnership

www.witec-eu.net
European Association for Women in Science, Engineering and Technology

www.expandingyourhorizons.org
Expanding Your Horizons Program—conferences for young women

www.femmesetsciences.fr
French association for women in science

www.uic.edu/orgs/gem-set/welcome.htm
GEM-SET—online group mentoring for girls in science, engineering and technology

www.girlsgotech.org
Girls Go Tech—introducing young girls to the world of technology

www.girlstart.org
Girlstart—empowering girls in math, science, engineering, and technology

www.ifuw.org
International Federation of University Women

www.inwes.org
International network focused on supporting women in science, technology, engineering and mathematics (STEM)

www.kineticcity.com
Kinetic City—games and experiments that make science fun for all ages

www.forwomeninscience.com
L'Oréal-UNESCO For Women in Science homepage

www.nasa.gov/audience/forstudents/index.html
NASA—section of the NASA website especially for young scientists

www.sciencecareers.org/lorealwis
Science/AAAS and L'Oreal—all previous Women in Science booklets (download PDF version of this booklet here)

www.sbfonline.com
Science Books & Films guide to science resources

www.scienceclubforgirls.org
Science Club for Girls—increasing the self-confidence and science literacy of K–12th grade girls

www.twows.org
Third World Organization for Women in Science

www.webgrrls.com
Webgrrls International

www.womeninbio.org
Women in Bio

www.witi.com
Women in Technology International

quest.arc.nasa.gov/women/intro.html
Women of the National Aeronautics and Space Administration (NASA)

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www.forwomeninscience.com

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2009 Laureate for Africa & Arab States
Tebello NYOKONG, South Africa

2008 Laureate for North America
Elizabeth BLACKBURN, USA

2002 Laureate for Asia-Pacific
Indira NATH, India

2009 Laureate for Latin America
Beatriz BARBUY, Brazil

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