

 AMERICAN MUSEUM OF NATURAL HISTORY

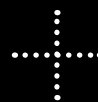
ROTUNDA

Member Magazine
Fall 2015 Vol. 40 No. 4



MEET YOUR MICROBES

THE SECRET WORLD INSIDE YOU
OPENS NOVEMBER 7



EXPLORING CUBA

From the President

Ellen V. Futter



Fall means “back to school,” and this year that phrase has new and deeper meaning at the Museum. Since 2011, we have been offering a Master of Arts in Teaching program in partnership with the Regents of the University of the State of New York. To date, 36 Kathryn W. Davis Teaching Fellows have graduated and are now teaching Earth and space science in high-needs schools in New York State. This innovative Master’s degree is the only such museum-based program in the country that is not affiliated with a university. Until recently, it has been operating in a pilot phase, and graduates have received their Master’s degrees from the Regents. I am pleased to report that this summer, the Regents, by unanimous vote, authorized the Museum to formalize this program under the auspices of our Richard Gilder Graduate School. Beginning with the class that enters in 2016, the Gilder Graduate School will confer the Master’s

degree, along with the Ph.D. degree in comparative biology that the Museum has been authorized to grant since 2006. This milestone not only validates our strategic vision to deepen and extend our longstanding work in teacher preparation but also signals the State’s confidence in our ability to provide a non-traditional, innovative, and uniquely effective solution to improving science teaching. And so, at the Gilder Graduate School’s Commencement this fall—our third—we will celebrate the Museum’s increasingly prominent formal role in higher education while saluting the achievements of another cohort of doctoral students earning Ph.D. degrees in comparative biology and Teaching Fellows receiving Master of Arts degrees in teaching. And we will very proudly send these bright young scientists and science teachers into a world that so sorely needs them.

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ROTUNDA

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Renovated Space Theater Reopens Next Month



New seats and a state-of-the-art screen are coming to the Hayden Planetarium Space Theater at the end of November.

The Hayden Planetarium’s Space Theater, which has been closed since mid-August while undergoing renovation, will reopen November 24 with a few improvements you won’t want to miss. While the updates include new carpet and refurbished seats, the main attraction in the 429-seat theater will be a state-of-the-art screen that will ensure the Hayden Planetarium’s award-winning Space Shows—including *Dark Universe*, which returns to view—are displayed to their full advantage. The Space Theater’s last screen, which was installed in 2000, has been a limiting optical factor for the dome, says Director of Rose Center Engineering Benjy Bernhardt. That’s due to the small but noticeable seams that hold it together. The new screen is built from thin sheets of aluminum and coated with powder to give it a startling white hue that makes it an ideal backdrop for planetarium projections. It’s held together by invisible “nanoseams” that make each of the pieces flush with one another, rather than overlapping. When a projection is shown on the dome, the seams disappear entirely, creating a fuller sense of reality and immersion for viewers. And while doors have been closed for the addition of the new screen, other upgrades have been going in too, all supported by the Charles Hayden Foundation. A new LED lighting system will be installed to cut heat generation and energy costs for lighting the dome, and the projector will be getting updated as well.

The Space Theater reopens November 24.

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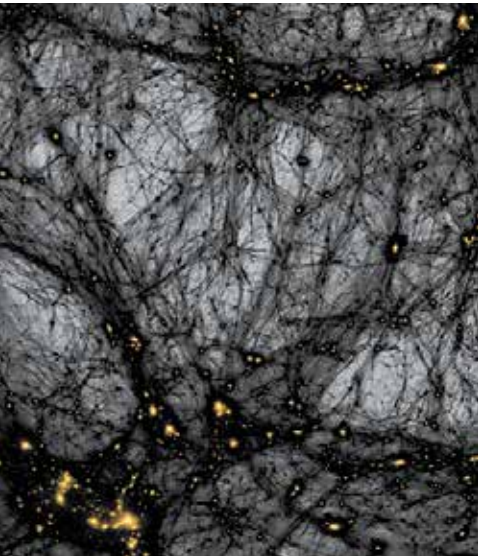
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Dark Universe Returns Nov. 24

When the Hayden Planetarium Space Theater reopens in November, it’s coming back with a bang—the Big Bang, in fact. The Museum’s latest Space Show, *Dark Universe*, returns to view this fall. In *Dark Universe*, astrophysicist and Frederick P. Rose Director of the Hayden Planetarium Neil deGrasse Tyson is your guide on a trip through space and time, from the Big Bang to a telescope in modern-day California. The destination: two recently discovered, and still mysterious, phenomena in astrophysics—dark matter and dark energy. Finding out more about dark energy and dark matter is key to understanding the nature of the world we live in. In stunning scenes based on scientific data—including a NASA probe’s breathtaking plunge into Jupiter’s atmosphere and groundbreaking visualizations of unobservable dark matter—*Dark Universe* explores this new age of cosmic discovery and reveals the mysteries that have been brought to light so far.

Please see page 18 for crediting information.



See a visualization of dark matter in the Space Show Dark Universe.

© AMNH/D. Finnin and R. Mickens

FOREVER YOUNGISH

Axolotls are neotenic animals, which means that they hold onto juvenile characteristics throughout their lives. These salamanders keep several such traits, like fins and lidless eyes, as adults, but their frilly gills—which they need to breathe underwater—may be the most striking of these features.

WATER WORLD

Most amphibians, such as newts and frogs, are born in water and transition to land when they become adults. Axolotls, though, retain their gills throughout their lives. While they are able to breathe air, the gills make them much more at home under water, where they spend most of their lives.

IN AQUARIUMS AND IN PERIL

Axolotls are bred in captivity around the world, sometimes as pets and sometimes as the subjects of scientific research. But native axolotls are only found in a handful of lakes and canals near Mexico City. Pollution in the region means that despite being a popular aquarium pet, axolotls are critically endangered in the wild.

BY ANY OTHER NAME...

The word “axolotl” comes from nahautl, the language of the Aztec people, and translates most closely as “water-monster.” Among modern aquarium enthusiasts, axolotls are sometimes referred to by the slightly more flattering—but no more accurate—term “walking fish.”

An Amazing Amphibian

The Museum hosts a wide variety of live animals in exhibitions, including several species of butterflies and spiders currently starring in special exhibitions. But this fall, Members can also get a close look at the astonishing salamander known as the axolotl (*Ambystoma mexicanum*).

Perhaps the most impressive quality possessed by axolotls is their incredible response to injury. These amazing amphibians have shown themselves capable of fantastic recovery, regenerating limbs and bouncing back from wounds without so much as a scar. Axolotls can even recover from trauma as grievous as a crushed spinal cord.

To perform these seemingly miraculous feats, the axolotl’s cells do an impressive bit of time travel. Near an injury like an amputated limb or tail, the cells undergo a process called de-differentiation: they lose their characteristics—the defining traits that make them skin cells or bone cells—and return to a state like that of stem cells, early cellular forms that can become any cell type.

Next, a structure called a blastema forms at the injury site, creating a kind of cap over the injured tissue. This blastema becomes the scaffolding for a new limb, where undifferentiated cells can congregate and get to the work of restoring the damaged—or even missing—tissue. Eventually, the blastema transforms into a functioning version of the lost limb. Since there’s no scarring, it’s difficult to tell anything had been missing.

Now researchers are studying the axolotl’s regenerative abilities to learn about which genes and proteins are involved in the process. The hope is that these lessons could one day be put to work to improve human healing.

See live axolotls in *Life at the Limits*, which is free for Members at the \$105 Membership level and above.



Ambystoma mexicanum



Catalog no. 70/8523

Clues for Conservation

For the last few months, Museum conservators have been working to treat and rehouse rare articles of clothing collected in Siberia more than a century ago during the Jesup North Pacific Expedition. Led by Franz Boas, who set out to study the cultures of indigenous peoples on both sides of the Bering Strait, the expedition team collected more than 5,000 items.

“This is one of our largest and oldest collections, regularly accessed by researchers from around the world,” says Judith Levinson, director of conservation in the Museum’s Division of Anthropology.

The collection includes two bridal coats made by the Sakha people, which Sakha scholar Zinaida Ivanova-Unarova suggests were made by a mother to guard her daughters as they were about to wed and begin families of their own. Each coat includes an eagle-shaped insignia on the back, possibly a family crest that symbolized this protective quality.

To better understand how these objects were made, conservators Jessica Pace and Amy Tjiong tapped into the expertise of colleagues from entirely different fields: mammalogy and genetics. They first turned to Neil Duncan, collections manager in the Department of Mammalogy, who provided hairs from hides of known origin in the Museum’s collection. Conservators used these to compare to hairs from the coats in order to identify the animals from which the coats were made. By looking at both samples under a microscope, Pace and Tjiong could examine the smallest details, like the hairs’ scaling. The conservators also worked with technician Rebecca Hersch in the Museum’s Sackler Institute for Comparative Genomics to extract DNA from the hairs to confirm the identifications, which determine how the objects are treated.

As they work to preserve these artifacts, a project supported by the Stockman Foundation Trust and the Institute of Museum and Library Services, Pace and Tjiong will also update the original collection records for future researchers.

Learn more at bit.ly/SiberianCollections.

COMPREHENSIVE COLLECTION

Even more impressive than the quantity of material collected by the Jesup North Pacific Expedition, which took place from 1897 to 1902, is its breadth. Collections range from photographs and models of dwellings to animal pelts and recordings—made on wax cylinders—of the languages of indigenous peoples.

PRESERVING TRADITION

After being repressed under the Russian Empire and Soviet regime, Sakha culture has undergone a revival in recent decades. During this period, numerous craftsmen and scholars have traveled from Siberia to study the Museum’s collection and to consult with conservators.

PLAYING FAVORITES?

One of the two bridal coats is fashioned from horse hide, while the other is crafted from higher quality—and more valuable—white reindeer hide. The white reindeer coat may have been made for a favored daughter in the family, but that’s a conjecture not even DNA analysis can confirm.

INFORMATION EXCHANGE

When researchers come from around the world to study the Siberian collection, they can also offer vital information. For example, visiting consultants helped conservators understand the provenance of these bridal coats.

REINDEER GAMES

Reindeer still play a central role in Sakha culture and life. The animals are celebrated at Sakha festivals and used for their hides, as well as for meat, milk, and transportation.

TEAM

YOU

**YOUR BODY HOSTS A VAST ARRAY
OF MICROSCOPIC LIFE THAT RESEARCHERS ARE
ONLY JUST BEGINNING TO UNDERSTAND.**

**THE SECRET WORLD
INSIDE YOU**
OPENS NOVEMBER 7



Physical contact—like the bumping during a roller derby bout—can change the population of microbes living on an individual's skin.

MEMBER PREVIEW:
THE SECRET WORLD INSIDE YOU
FRIDAY, NOVEMBER 6
4–8 PM
FOR MEMBERS AT THE \$105 LEVEL AND ABOVE
RSVP AT 212-769-5606

Be among the first to experience our new special exhibition
THE SECRET WORLD INSIDE YOU before it opens to the public!
Join us on Friday, November 6, for an exclusive Member
Preview. There will be a reception from 4:30–8 pm in the Akeley
Hall of African Mammals with wine and nonalcoholic drinks.

WHAT'S INSIDE YOU?

Our bodies are home to approximately 100 trillion bacteria living inside us and on us—a vast community known as our microbiome. Fascinating new research is revealing how many of these microbes work with the body to manufacture vitamins, boost our immune systems, and even affect how we feel.

The Secret World Inside You explores the rapidly evolving science that is revealing the complexities of the human microbiome and reshaping our ideas about human health, offering new perspectives on common health problems including allergies, asthma, and obesity.

The exhibition is co-curated by Susan Perkins and Rob DeSalle, curators in the Division of Invertebrate Zoology and the Sackler Institute for Comparative Genomics.

The Secret World Inside You is supported by the Science Education Partnership Award (SEPA) program of the National Institutes of Health (NIH).

There's a growing consensus in the scientific community: you are a superorganism.

That doesn't mean that you can see through walls or leap tall buildings in a single bound. It's a way of saying that, more than being individuals, humans are ecosystems. Our bodies host trillions of microbial life forms, too small to see but vitally important to our lives and health. You can get a tour through the amazing ecosystems present in all of us in the Museum's latest exhibition, *The Secret World Inside You*.

OUR MICROBES, OURSELVES

The number and diversity of these microbes is hard to overstate. There are more microorganisms living on and in you than there are stars in the Milky Way galaxy. In fact, the much smaller life forms that make up your microbiome—that's the word used to describe the totality of microbes and their genetic material present in your body—are at least as numerous as your own eukaryotic cells, or cells with a membrane-enclosed nucleus. Some estimates suggest each of us hosts about 10 microbes for every one of our human cells. The total weight of all the bacteria in your body is about 5 pounds. In other words, if your whole microbiome were a single organ, it would be about the size of your brain. On a genetic level, the difference is even more drastic: your human genes are outnumbered by microbial genes by at least 100 to one.

These microscopic organisms include viruses, fungi, and archaea. But far and away the most populous microbes in our microbiome are bacteria. There's practically no place in or on your body that's not colonized by a variety of bacterial species—and, just like other species on Earth, their distribution and variety change depending on location. The bacterial community of the dry, light-exposed skin on your face and the dark, moist skin of your armpit are as different from one another as the flora and fauna in a desert and a rain forest. Even more amazingly, the microbial communities on your right and left hands—or in your right and left ears—are also distinct.

Scientists have only recently started studying the microbiome in depth. Since 2007, the Human Microbiome Project has been sampling, analyzing, and identifying the tiny life forms that make up humans' resident microbe communities. Two years ago, the organization published the results of the first-ever census of the human microbiome, which analyzed the microbial populations of people from different parts of the world.

The results gave researchers a good starting point but also demonstrated how far we are from truly understanding these microbial populations and the roles they play in our lives. One thing is certain: their influence on our health is only beginning to be uncovered. To underline their clout, researchers have started referring to these ill-understood populations of microbes as the human body's "hidden organ." But what is this hidden organ made of? What does it do? And how do we develop it—and change it?

MAKING A MICROBIOME

Our microbiome begins forming before we're born, and it grows and changes with us over the course of our lives. It reflects the places we go and the things we do, and, like fingerprints, irises, and DNA profiles, no two human microbiomes are the same.

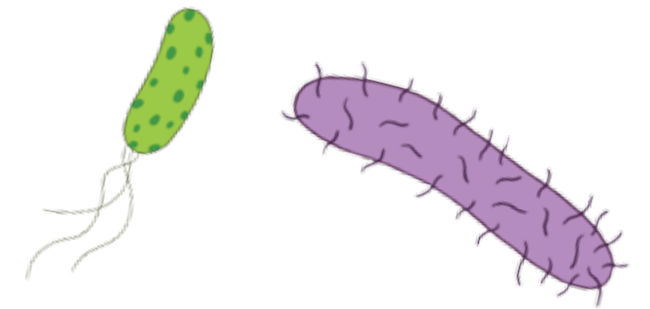
While we get our genes from both parents, early studies suggest that our first microbiomes are gifts from our mothers. During pregnancy, women's gut and reproductive microbiomes undergo a series of changes, some of which seem to help weight gain during pregnancy and others that appear to stabilize the microbial inheritance that the baby receives first in the womb, and then again when it passes through the birth canal.

Skin-to-skin contact introduces infants to additional microorganisms. And breast milk turns out to be a bacterial brew, with more than 700 microbial species delivered directly to the baby. In addition to bacteria, breast milk contains sugars that can't be digested by humans—and so appear to be included specifically to feed and nurture the baby's early microbial hangers-on.

While we get our first microbes from mom, these populations are always changing. Touching a doorknob or riding public transit can introduce new microbes to your skin microbiome, for example. And, as it turns out, other people can literally rub off on you. A 2013 study of roller derby competitors found that after a match—which, as derby fans know, involves lots of physical contact—the skin microbiomes of the players had temporarily become more similar than before. All that bumping and jostling provided the perfect way for microbial populations to find a new home.

Even changing your diet can alter your microbiome, providing food that is better for some microbial communities and helps them thrive, and worse for others, which may be hampered or die out completely. These changes to microbial populations can happen especially quickly in the human gut, which hosts a huge number of the body's microbes. Just four days on a new diet—one that's exclusively vegetarian, or entirely based on animal products—may be enough to radically reshape the bacterial population of your gut.

**THERE'S A GROWING
CONSENSUS IN THE
SCIENTIFIC COMMUNITY:
YOU ARE A
SUPERORGANISM.**



MICROBES WITH MERIT

The makeup of your bacterial team isn't totally understood yet, but studies (done mostly in model animals, like mice) suggest that the microbiome plays a major role in human health, from immune system response to inclination towards obesity. (For more, see the story on p. 10.) Studies have even found that microbiomes can have an effect on the moods of mice, suggesting that the bacteria in our gut could similarly play a role in conditions like depression.

Getting a better understanding of just how these bacteria work in our bodies, and what the balance of different bacterial communities needs to be, is turning out to be one of the more pressing issues in human health. The early results, though, have researchers questioning the wisdom of overusing products like antibacterial hand sanitizers, which can wipe out all bacteria on the patch of skin being "cleaned," good and bad alike. When you carpet-bomb bacteria that way, you could be taking out innocuous microbes and giving detrimental ones the opportunity to dominate their ecosystem.

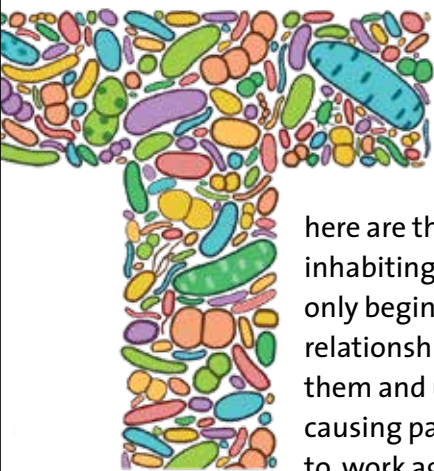
The same principle is fueling new questions about antibiotic use—and overuse. Researchers like Martin Blaser at New York University have conducted studies suggesting that rapidly increasing antibiotic use in the United States may be connected to high obesity rates and other unforeseen effects. Some doctors are also beginning to prescribe probiotics—substances that can feed and strengthen the microbes in your gut—alongside antibiotics, a practice that studies have suggested can alleviate the stomach problems sometimes associated with antibiotic use.

There are other concerns as well. While microbiomes can change over time, the microfauna population of humans in industrialized nations seems to be getting less diverse. Earlier this year, researchers took samples of the microbiomes of members of the Yanomami tribe, a people living in the Amazon rain forest who have had minimal contact with the outside world. The 34 members of the Yanomami who were tested provided researchers with an incredibly varied swath of microbial life. That diversity, which may be attributable to the Yanomami's lack of exposure to antibiotics and to their hunter-gatherer lifestyle, could provide a window into the pre-industrial past, letting us see what our microbiomes may have looked like before penicillin, processed foods, and yes, Purell.

The special exhibition *The Secret World Inside You* opens November 7 and is free for Members at the \$105 level and above.

SUPPORTING PLAYERS

ARE YOUR BODY'S BACTERIA FRIEND OR FOE, PATHOGEN OR PROTECTOR? IT'S COMPLICATED.



There are thousands of species of bacteria inhabiting our bodies, but researchers are only beginning to understand the complex relationships among them—and between them and us. Some are known to act as disease-causing pathogens. Others not only appear to work against less beneficial bacterial brethren, but also to work for us in a variety of ways, from aiding digestion to protecting our teeth.

It's a complicated dynamic, but it seems that some microbes can be good or bad, depending on the size of their population and on conditions in their ecosystem, the human body. The key? Balance. Maintaining a healthy equilibrium is an important role played by the microbes featured below—bacteria that, you might say, have your back.

SKIN DEEP

Perhaps not surprisingly, skin, our interface with the world, supports the body's most diverse population of bacteria. There are at least 1,000 different species found on skin, along with dozens of fungi and other microbes. Most of these bacteria aren't harmful, and many serve a protective function. They live among the dead skin cells that make up the outer layer of our skin while defending their own turf against other microbes. One strain of the bacterium *Bacillus subtilis*, which is sometimes found on the skin, produces bacitracin—a common ingredient in many over-the-counter antibiotic ointments. *B. subtilis* also releases toxic chemicals to kill fungus, possibly including *Trichophyton interdigitale* and other species that cause athlete's foot.

LOOK, MA, NO CAVITIES!

Who isn't familiar with the dreaded strep throat? An extremely painful form of pharyngitis, or inflammation of the back of the throat, it's caused by the bacterium *Streptococcus pyogenes*—hence its name—which is also the culprit in rheumatic heart disease. But there are more than 50 recognized species of *Streptococcus*, many of them regular denizens of the human mouth, respiratory tract, and elsewhere. Some, like *S. pyogenes*, are proven pathogens, the cause of everything from cavities (*S. mutans*) to pneumonia (*S. pneumoniae*). But others seem to do no harm and may even help by working against troublesome strains of fellow streptococci. *Streptococcus salivarius*, for example, which is found in the human mouth and respiratory tract, can be dangerous, even lethal, to people with weakened immune systems in the rare event it escapes outside the oral cavity. But in the mouth, it appears to help prevent both gum disease and tooth decay. When cultured side by side in the lab, *S. salivarius* inhibited the formation of decay-causing plaque by *S. mutans*.

COLON COLONY

By far the largest population of bacteria in the human body is found in the colon. The majority are anaerobic, which means they don't require oxygen and, of these, species of the genus *Bacteroides* are among the most common. Outside the gut, strains of *Bacteroides* can cause abscesses in the abdomen, brain, liver, pelvis, and lungs, as well as bacteremia or infection of the bloodstream. But in the colon, they serve important functions, breaking down carbohydrates, producing enzymes specifically designed to deal with different foods, and extracting energy from those foods. One species, *B. fragilis*, appears to stimulate immune cells called regulatory T-cells, which restrain aggressive inflammatory T-cells that can trigger colitis and other disorders. Researchers are also beginning to tease out the possible relationship between the overall makeup of a person's gut microbiome and a propensity toward obesity. In any case, the usefulness and ubiquity of bacteria in the colon probably can't be overstated. Three-quarters of human feces is water and, of the remaining quarter, one-third is composed of bacteria—or as Giulia Enders, author of *Gut: The Inside Story of Our Body's Most Underrated Organ*, describes them, "gut flora that ended their careers in the digestive business and are ready to retire from the workplace."

GUT FEELING

In the mid-1980s, internist Barry J. Marshall tested, and proved, his theory that ulcers could be cured with antibiotics by infecting himself with the corkscrew-shaped bacterium *Helicobacter pylori*. This not only earned him the nickname "guinea-pig doctor" but also the Nobel Prize, which he shared in 2005 with pathologist J. Robin Warren for their discovery that *H. pylori* caused gastritis (irritation or inflammation of the stomach lining) and peptic ulcers, diseases that were long thought to be caused by excess acid resulting from stress. Their work led to the near-eradication of stomach ulcers in developed countries through treatment with antibiotics, as well as to a drop in stomach cancers, for which gastritis is a risk factor. But as welcome as these cures are, researchers now think *H. pylori* isn't just a pathogen. Studies strongly suggest that it is essential to the prevention of asthma, allergies, gastroesophageal reflux disease, and esophageal cancer.

MAKE YOUR OWN MICROBIAL MEDLEY

A FAMOUS INVESTIGATION YOU CAN DO AT HOME

The poet William Blake prodded us to “see a world in a grain of sand,” and this simple project does just that—only with a cupful of mud! Just add a few other easy-to-find ingredients to create an entire ecosystem for bacteria called a Winogradsky column, named for a Russian microbiologist. Over several weeks, different species will separate into visible layers depending on how they use—or don’t use—oxygen, light, and nutrients such as carbon or sulfur. It’s a living lesson in how microbes play an essential role in the life cycle as they reuse and recycle nutrients, not unlike the way the bacteria that inhabit our bodies break down foods to give us energy. Or as Rob DeSalle, co-curator of the special exhibition *The Secret World Inside You*, likes to say: “The human digestive tract is one huge Winogradsky column.”

HOW TO CONSTRUCT THE COLUMN

WHAT YOU NEED

A bucket and shovel to collect mud



One plastic bottle



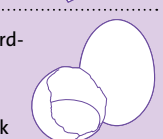
Two mixing bowls and spoon



One sheet of newspaper



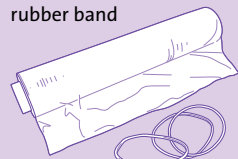
One hard-boiled or raw egg yolk



Water, from the tap or your mud source



Plastic wrap and rubber band



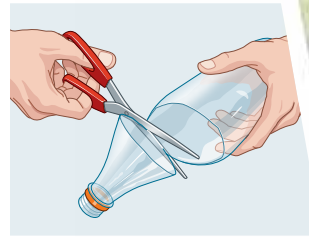
1

Dig mud from top layer of pond, puddle, or riverbed. Remove rocks, twigs, and other solids.



2

Cut off the top of the bottle and save as a funnel for the mud.



3

Put enough mud into mixing bowl to nearly fill the bottle. Add water and stir until the mud is the consistency of a milkshake. Reserve 3/4 of the mud.



4

Into remaining 1/4 mud, stir egg yolk and handful of shredded newspaper. (Wash hands if using raw egg.)



5

Spoon egg-paper-mud mixture through funnel, tapping bottle on table occasionally to remove air pockets as mud settles. In same way, top with reserved mud.



6

Add an inch or so of water, leaving air at the top.



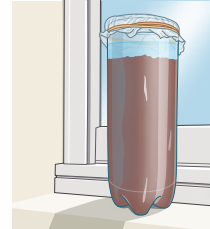
7

Cover with plastic wrap and secure with a rubber band.



8

Place your column near a brightly lit window but not in direct sunlight.



KEEP A LOG

Over the next six to eight weeks, watch for various color bands to form. At least once a week, on the same day and at the same time, write down any changes you see, including colors, the movement or thickening of sediment, and any differences between the side facing the light and the one facing away. Take photos for comparison, being careful to note the day and time the photo was taken.



RESULTS
MAY
VARY

WHAT IS GOING ON?

Some bacteria in the mud get their nutrients by breaking down the newspaper and the egg yolk, releasing carbon dioxide and hydrogen sulfide, respectively. A chain of consumption and conversion is set off up and down the column, as bacteria break down compounds and recycle carbon, hydrogen, sulfur, and oxygen according to need. Bacteria that require oxygen (aerobic bacteria) will thrive toward the top of the column, while those that only tolerate it or cannot abide it at all (anaerobic bacteria) will proliferate in the lower sections. This idealized version illustrates the various layers that might form.

CYANOBACTERIA

About two billion years ago, bacteria like these appeared and produced the oxygen-rich atmosphere that paved the way for green plants and other life on Earth. They use sunlight, carbon, and hydrogen to produce energy while giving off oxygen.

PURPLE NON-SULFUR BACTERIA

Purple non-sulfur bacteria, anaerobic bacteria that come in a range of colors, derive their energy from sunlight and carbon.

PURPLE AND GREEN SULFUR BACTERIA

Purple and green sulfur bacteria, also anaerobes, use light, carbon, and hydrogen.

SULFATE-REDUCING BACTERIA

Anaerobic sulfate-reducing bacteria consume the egg yolk, releasing hydrogen sulfide, which, not surprisingly, smells like rotten eggs and is definitely not for human consumption! These bacteria are like the ones that thrived for the first two to four billion years of life on the planet, before the appearance of cyanobacteria.

COLOR CHART

Your column may include colonies of the following types bacteria, from top to bottom:



GREEN
cyanobacteria



PURPLE, BROWN, ORANGE, RED
purple non-sulfur bacteria



PURPLE
Purple sulfur bacteria



DARK GREEN
Green sulfur bacteria



BLACK
Sulfate-reducing bacteria

WANT MORE WINOGRADSKY?

The Museum's science website for kids, OLogy, is launching a new section this month. Visit AMNH.ORG/OLOGY/MICROBIOLOGY for more Winogradsky column projects and to learn more about the human microbiome.

Programs and Events

For more programs and to purchase tickets, visit amnh.org/calendar.

For updates and reminders, sign up for monthly Calendar Highlights for Members by sending your membership number and request to subscribe to members@amnh.org. The Museum does not trade, rent, or sell this information.

Tickets

Tickets are available by phone at 212-769-5200, Monday–Friday, 9 am–5 pm, or by visiting amnh.org. Please have your membership number ready.

Availability may be limited. Please purchase tickets in advance.

Please be aware that ticket sales are final for all Member programs. All programs go ahead rain or shine. There are no refunds unless the program is cancelled by the Museum.

Information about programs is current as of September 1, 2015. Please check amnh.org/calendar for updates.

OCTOBER



SciCafe: Seeing Inside Bats
Wednesday, October 7
7 pm

Free for 21+ with ID
Join Curator **Nancy Simmons** and postdoctoral fellow **Abigail Curtis** from the Museum's Department of Mammalogy for an exciting journey inside the world (and bodies!) of bats. Using CT-scanning technology, Simmons and Curtis are taking a new look at bat skeletons from their wrists to their sinuses.

Behind the Scenes: Sackler Institute for Comparative Genomics
Thursday, October 15
6:30–7:30 pm, 7–8 pm,
7:30–8:30 pm
\$30

Director **George Amato** and Collections Manager **Julie Feinstein** lead a rare tour of the Sackler Institute for Comparative Genomics, a state-of-the-art facility devoted to genomic research. Explore the Museum's frozen-tissue collections, view equipment used in labs, and learn about current research being conducted by Museum scientists.



Sackler Brain Bench Stem Cells In Neuroscience: Promises, Challenges, and New Frontiers

Saturday, October 17
9 am–4 pm
\$85; Lunch will be served

What are stem cells, and what promise do they hold for the treatment of neurological diseases? Join us for a one-day course where we delve into recent advances in this area of research. Explore how stem cells have been used to model diseases, understand disease progression at the cellular level, and develop new treatments for serious neurological conditions. A diverse group of experts will present research at the frontiers of the field.

Birding in Green-Wood Cemetery with Paul Sweet
Saturday, October 17
10 am–1 pm
\$25

Observe the fall migration at Green-Wood Cemetery with Ornithology Collections Manager **Paul Sweet**. Green-Wood Cemetery hosts a colony of Monk parakeets and is also an ideal place to observe migrating birds, particularly raptors. With fall foliage in full color, many birds find sanctuary among the trees, shrubs, and graves of the cemetery.

Highlights Tour: Hidden Treasures of the Museum
Sunday, October 18
3–5 pm
Free; reservations required

Join a tour guide to explore the Museum's halls and discover some of their best-kept secrets. Learn the fascinating stories behind treasures found in the Harry Frank Guggenheim Hall of Minerals, the Arthur Ross Hall of Meteorites, the Spitzer Hall of Human Origins, and more! This tour is for Members ages 12 and up.



Frontiers Lecture: From Mars to the Stars
Monday, October 19
7:30 pm
\$12

Mars may be the only destination beyond the Moon to ever see human footprints. Join aerospace engineer **Louis Friedman** as he shares a provocative vision for the future of space travel. In his latest book, Friedman suggests that space travel will continue well into the future, human travel beyond Mars will become an obsolete idea, supplanted by evolving nano and bio-technologies and by an ever-expanding information age.

The 2015 Margaret Mead Film Festival: Thresholds
October 22–25
Visit amnh.org/mead for tickets and showtimes.

The annual Margaret Mead Film Festival is the preeminent showcase for contemporary cultural media and conversation in the unique setting of the Museum. In an era defined by mobility and transformation, the artists and filmmakers of this year's festival explore boundaries of all kinds—geographic, cultural, personal, and metaphysical—that define contemporary life across Earth.



Questions for a Resilient Future: What Connects Culture and Conscience
Monday, October 26
6–8 pm
Free; reservations required

The Center for Humans and Nature's Senior Scholars, anthropologist **Melvin Konner** and social psychologist **Jonathan Haidt**, will offer brief talks in response to the question: what are the connections between culture and conscience? They will further unravel their ideas in conversation with Krista Tippet, host of NPR's *On Being*.

Thunder & Lighting: Weather Past, Present, Future
Thursday, October 29
6:30 pm
Free; reservations required

Lauren Redniss, author of *Radioactive: Marie & Pierre Curie* debuts her new title. Developed while she was an artist in residence at the Museum, *Thunder & Lightning: Weather Past, Present, Future* brings her unique style to a journey from the driest desert on Earth to an island in the Arctic and beyond.

Exhibitions

Admission is by timed entry only.

The Secret World Inside You

Free for Members at the \$105 level and above
Explore the new world that's being discovered in human bodies. New research shows that, rather than make us sick, many bacteria living in and on our bodies are often key to our health.



Life at the Limits: Stories of Amazing Species

Free for Members at the \$105 level and above
Discover the diverse and jawdropping strategies animals and plants employ to find food, fend off predators, reproduce, and thrive in habitats we would find inhospitable, even lethal.



Opulent Oceans

Free for Members

Inspired by the book *Opulent Oceans: Extraordinary Rare Book Selections from the American Museum of Natural History*, this exhibition includes exquisite reproductions from 46 rare and beautifully illustrated scientific works.



Countdown to Zero: Defeating Disease

Free for Members

This exhibition, developed in collaboration with The Carter Center, highlights scientific and social innovations that are ridding the world of ancient afflictions—including the 30-year campaign that may soon eradicate Guinea worm disease.



NOVEMBER

Sackler Brain Bench Brain: The Inside Story
Mondays, November 2–November 30
6 pm–8 pm
\$295

The brain is your window to the world around you. Join us for a five-part introductory course exploring the inner workings of this magnificent and mysterious organ with experts who will discuss the latest neuroscience research. Learn how the brain senses, feels, thinks, and ages.

Member Preview:
The Secret World Inside You
Friday, November 6
4–8 pm
Free for Members at the \$105 level and above; reservations required at 212-769-5606
Members are invited to see the new exhibition, *The Secret World Inside You* at a special preview, with a wine reception in the Akeley Hall of African Mammals. See page 8 for more information about the exhibition.



SciCafe: How the Brain Shows Its Feminine Side
Wednesday, November 4
7 pm
Free for 21+ with ID
Researcher **Bridget Nugent** explains epigenetics and the origins of sex differences in the brain.

Highlights Tour: Hall of Planet Earth
Saturday, November 7
10:30 am–noon
Free; reservations required
How did the Earth form? How do we know what the planet was like four billion years ago? What causes earthquakes and volcanoes? Join a Museum guide as you explore the planet we call home.

Frontiers Lecture: Spooky Action at a Distance
Monday, November 9
7:30 pm
\$12
“Spooky action,” the ability of one particle to affect another instantly across the vastness of space, appears to be almost magical. **George Musser**, author of *Spooky Action at a Distance: Why Space and Time are Doomed and What It Means for Black Holes, the Big Bang, and Theories of Everything*, sets out to explore the phenomenon.

IRIS Lecture: The Global Surge of Great Earthquakes
Thursday, November 12
6:30 pm
Free; reservations required
Eighteen earthquakes of seismic magnitudes greater than 8.0 have struck around the world in just the past decade. Join **Dr. Thorne Lay** as he discusses how analysis of these earthquakes forced researchers to revise long-standing ideas about the behavior of huge fault ruptures.

Live Bat Encounter
Saturday, November 14
11 am (recommended for young children), 1 pm, 2:30 pm
\$12
Get an up-close and personal introduction to live bats from around the world! Conservation biologist and bat expert **Rob Mies** will give an unforgettable presentation with live bats, including a Malayan flying fox, the world’s largest bat species.



A Natural History of Wine
Tuesday, November 17
6:30 pm
\$20
Join Museum Curator Emeritus **Ian Tattersall** and Curator **Rob DeSalle** as they weave together their respective fields—paleoanthropology and molecular biology—in an exciting journey through the world of wine. Enjoy tastings and a grand tour of the science and history of wine.



Please check amnh.org for Member ticket prices for live animal exhibits and giant-screen 2D and 3D films.

Spiders Alive!
Spiders Alive! immerses visitors in the fascinating and complex world of spiders.

The Butterfly Conservatory
Species in this ever-popular exhibition include iridescent blue morpho butterflies and large owl butterflies.

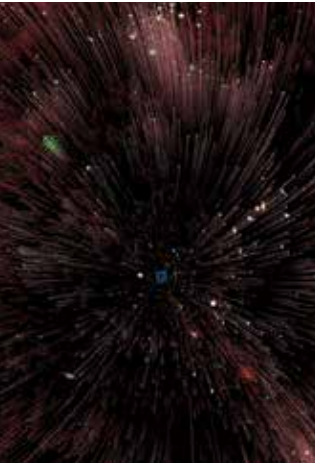


Jean-Michel Cousteau’s Secret Ocean
Jean-Michel Cousteau’s *Secret Ocean* introduces audiences to more than 30 marine species and behaviors captured for the first time thanks to groundbreaking advances in underwater filming. Narrated by renowned oceanographer Sylvia Earle, this 40-minute giant screen film is showing in 2D and 3D.

Hackathon
Sunday, November 22
Free
The Museum’s Hackathon returns for a weekend of presentations, activities, and demonstrations highlighting the role computer science plays in studying, visualizing, and understanding science.

DECEMBER

Jesup Society Reception
Tuesday, December 1
4:30–6:30 pm
RSVP required; call 212-769-5119 or email plannedgiving@amnh.org
Join us and a Museum curator for a private viewing of our latest exhibition, *The Secret World Inside You*, at this exclusive event for Jesup Society members only. The Jesup Society honors those who have made bequests or life income gifts to the Museum. Wine and hors d’oeuvres will be served; please call 212-769-5119 or email plannedgiving@amnh.org for more information.



Painting the Natural World
Eight Tuesdays, December 1, 2015–January 19, 2016
7–9 pm
\$240
In an after-hours painting workshop in the Akeley Hall of African Mammals, artists **Eric Hamilton** and **Greg Follender** provide hands-on instruction in acrylic paint. Get a glimpse into the history and craftsmanship behind world-class dioramas and take home a painting of your own. Basic painting ability is recommended for this course.

SciCafe: Mapping our Microbial Ecosystem
Wednesday, Dec 2
7 pm
Free for 21+ with ID
It is estimated that Americans spend approximately 92 percent of their time indoors, yet we know little about the diversity of microbes that exist in this built environment. Geneticist **Jack Gilbert** will present on the most recent discoveries in this area, discussing the complexities of this research and providing a guide for understanding the microbiome and the role diet and lifestyle play in shaping this health resource.



Family Bird Walks
Saturday, December 5
9 am, 11:30 am, 2 pm
\$15
Explore the birds of Central Park with Museum naturalist **Noah Burg**. Young explorers will begin their adventure by learning the tools and skills of observation using Museum specimens. Then, head out to Central Park to identify the many bird species and habitats in our own backyard. Binoculars and bird guides are included. This program is recommended for families with children ages 4–10.

Frontiers Lecture: Dark Matter and the Dinosaurs
Monday, December 7
7:30 pm
\$12
Join physicist **Lisa Randall** as she discusses her book *Dark Matter and the Dinosaurs*, which weaves together the histories of Earth and the larger cosmos.

Exhibition Credits
The American Museum of Natural History gratefully acknowledges the Richard and Karen LeFrak Exhibition and Education Fund.

Generous support for Life at the Limits has been provided by the Eileen P. Bernard Exhibition Fund.

Life at the Limits is proudly supported by Chase Private Client.

OrigamiFest
Sunday, December 13
30-minute sessions from 10:30 am–2:30 pm
\$5; reservations required
Fold, crease, and create an assortment of origami models with a team of volunteers from OrigamiUSA. Enjoy a display of some of OrigamiUSA’s most complex creations, snack on cookies and milk as you fold, and then take home a collection of your own making for the holiday.

Members-Only Highlights Tour
Saturday, December 19
2–3:30 pm
Free; reservations required
Families are invited to take part in this tour for adults and children alike. Experts will guide you through the Museum’s halls to explore some family favorites.

The Secret World Inside You is supported by the Science Education Partnership Award (SEPA) program of the National Institutes of Health (NIH).

The presentation of Opulent Oceans: Extraordinary Scientific Illustrations from the Museum’s Library is made possible by the generosity of the Arthur Ross Foundation.



Winter Telescope Party
Monday, December 21
7 pm
\$12

Join us for a sneak peek of the celestial objects that will appear in our winter sky. Learn the techniques of observation from inside the Hayden Planetarium. Weather permitting, head out to the Arthur Ross Terrace, where you can sip hot chocolate as you look through telescopes with members of the Amateur Astronomers Association.

Celebrate Culture!
KWANZAA 2015:
Energize, Recognize!
Sunday, December 27
Noon and 3 pm
Free
Harlem native and “human beatbox” **Doug E. Fresh** rings in the new year at the Museum’s 37th annual Kwanzaa spectacular! Storyteller **Linda Humes** guides us through a celebration of the roots of the African-American community, drawing on seven universal principles. An international marketplace and a special film screening complete the Museum’s Kwanzaa festivities.



Credits:
The Museum gratefully acknowledges The Mortimer D. Sackler Foundation, Inc. for its support to establish the Sackler Brain Bench, part of the Museum’s Sackler Educational Laboratory for Comparative Genomics and Human Origins, in the Spitzer Hall of Human Origins, offering ongoing programs and resources for adults, teachers, and students to illuminate the extraordinary workings of the human brain.

Support for Hayden Planetarium Programs is provided by the Schaffner Family and the Horace W. Goldsmith Endowment Fund.

The Margaret Mead Film Festival is made possible by the New York State Council on the Arts with the support of Governor Andrew M. Cuomo and the New York State Legislature.

Support for Celebrate Culture Programs including the Margaret Mead Film Festival and KWANZAA 2015 is provided, in part, by the May and Samuel Rudin Family Foundation, Inc.; the Sidney, Milton and Leoma Simon Foundation; the family of Frederick H. Leonhardt; and The Max and Victoria Dreyfus Foundation.

The Annual IRIS/SSA Lecture Series is presented in collaboration with the Incorporated Research Institutions for Seismology and the Seismological Society of America.

The Hackathon is part of BridgeUp: STEM, an educational initiative focused on the intersection of cutting edge computing, scientific research, and science communication.

BridgeUp: STEM is generously supported by a grant from the Helen Gurley Brown Trust.

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OCTOBER

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WEDNESDAY
SciCafe: Seeing Inside Bats
SciCafe

15
THURSDAY
Behind the Scenes: Sackler Institute for Comparative Genomics
Member Program

17
SATURDAY
Stem Cells in Neuroscience: Promises, Challenges, and New Frontiers
Adult Course

Birding in Green-Wood Cemetery with Paul Sweet
Member Program

18
SUNDAY
Highlights Tour: Hidden Treasures of the Museum
Member Program

19
MONDAY
Frontiers Lecture: From Mars to the Stars
Hayden Planetarium Program

22
THURSDAY
The 2015 Margaret Mead Film Festival
Though October 25

26
MONDAY
Questions for a Resilient Future: What Connects Culture and Conscience
Museum Lecture

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2
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Member Program

19
SATURDAY
Members-Only Highlights Tour
Member Program

21
MONDAY
Winter Telescope Party
Hayden Planetarium Program

27
SUNDAY
KWANZAA 2015: Energize, Recognize! Celebrate Culture!

29
TUESDAY
Astronomy Live: Grand Tour of the Universe
Hayden Planetarium Program

Exhibition Credits
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Countdown to Zero is proudly supported by Conrad N. Hilton Foundation, Lions Clubs International Foundation, Mectizan Donation Program, and Vestergaard.

This exhibition is made possible by the generosity of the Arthur Ross Foundation.

Generous support for The Butterfly Conservatory has been provided by the Eileen P. Bernard Exhibition Fund.

Jean-Michel Cousteau’s Secret Ocean is directed by Jean-Michel Cousteau and produced by Ocean Futures Society and 3D Entertainment Films.

Dark Universe was created by the American Museum of Natural History, the Frederick Phineas and Sandra Priest Rose Center for Earth and Space, and the Hayden Planetarium.

Made possible through the generous sponsorship of Accenture.

And proudly supported by Con Edison.

The Museum also gratefully acknowledges major funding from the Charles Hayden Foundation. Presented with special thanks to NASA and the National Science Foundation.

Dark Universe was developed by the American Museum of Natural History, New York (www.amnh.org) in collaboration with the California Academy of Sciences, San Francisco, and GOTO INC, Tokyo, Japan.



EXPLORING CUBA

MORE THAN A CENTURY AFTER THE FIRST MUSEUM EXPEDITION TO CUBA, A NEW ERA OF SCIENTIFIC EXPLORATION BEGINS.

Scientists from the Museum first traveled to this extraordinary Caribbean island 120 years ago to study its unique native birds, reptiles, mammals, and fishes. Research expeditions—and collaborations with Cuban colleagues at the Universidad de La Habana, the Academia de Ciencias de Cuba, and the Museo Nacional de Historia Natural—continued until the Cuban revolution in 1959 led to a 25-year pause. Expeditions resumed in the mid-1980s as researchers headed back to Cuba to confirm sightings of the elusive Ivory-billed Woodpecker. Research trips over the past 30 years have included studies of Cuba's birds, fossils, geology, spiders, and more, and in 1997 the Museum's Center for Biodiversity and Conservation offered a course at the Museo Nacional. The Museum continues this legacy with the upcoming Explore21 Expedition to Cuba, an exciting new effort to learn more about this intriguing island.



©AMNH / 5W Infographics

SEE FOR YOURSELF!

TRAVEL TO CUBA WITH THE MUSEUM IN 2016.

FOR MORE INFORMATION, VISIT AMNH.ORG/CUBA

- KEY**
- Select pre-2015 Museum expeditions to Cuba
 - Proposed sites for the upcoming Explore21 Expedition to Cuba

The Museum's Explore21 initiative is supported by the leadership contributions of Katheryn P. and Thomas L. Kempner, Jr., and Linda R. and William E. Macaulay.

2015 Museum Highlights

Here's a look at some of the moments that made last year so memorable at the Museum.



PRESIDENT JIMMY CARTER VISITS

To mark the opening of Countdown to Zero, developed with The Carter Center, President Jimmy Carter visited the Museum in January to discuss efforts to eradicate Guinea worm.



STARTALK TV SHOW PREMIERES

Neil deGrasse Tyson's lauded podcast StarTalk came to TV screens on the National Geographic Channel, with episodes filming at the Museum.



SCIENCE AND NATURE PROGRAM GRADUATION

The Museum's Science and Nature program celebrated the latest class of young naturalists.



GOOGLE FIELD TRIP

More than 3,000 students from 47 schools attended Google Field Trip Day at the Museum, touring the halls and participating in hands-on educational activities.



URBAN ADVANTAGE SCIENCE EXPO

Carmen Fariña, Chancellor of the New York City Department of Education, visited with students presenting science projects conducted as part of the Urban Advantage middle-school science initiative.



NEW HORIZONS PLUTO FLYBY

Museum visitors of all ages watched up-to-the-second science visualizations and heard live commentary from mission scientists as the New Horizons probe made its historic flyby of Pluto in July.

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New York, New York 10024-5192
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Cabrillo College lab technician Tasha Sturm grew this sample of the microbes found on her 8-year-old son's hand after he was outside playing. Learn more about your own microscopic neighbors in the special exhibition *The Secret World Inside You*, which opens November 7 and is free for Members at the \$105 level and above.

General Information

HOURS

Museum: Open daily, 10 am–5:45 pm;
closed on Thanksgiving and Christmas.

ENTRANCES

During Museum hours, Members may
enter at Central Park West at 79th Street
(second floor), the Rose Center/81st Street,
and through the subway (lower level).

RESTAURANTS

Museum Food Court, Café on One,
Starlight Café, and Café on 4 offer
Members a 15-percent discount.
Hours are subject to change.




MUSEUM SHOPS

The Museum Shop, Dino Store,
Shop for Earth and Space,
Cosmic Shop, Life at the Limits Shop,
The Secret World Inside You Shop,
and Online Shop (amnhshop.com)
offer Members a 10-percent discount.

PHONE NUMBERS

Central Reservations 212-769-5200
Membership Office 212-769-5606
Museum Information 212-769-5100
Development 212-769-5151

TRANSPORTATION AND PARKING

Subway:  (weekdays) or  to 81st Street;
 to 79th Street, walk east to Museum
Bus: M7, M10, M11, or M104 to 79th Street;
M79 to Central Park West
Parking Garage: Open daily, 8 am–11 pm;
enter from West 81st Street. Members can park
for a flat fee of \$10 if entering after 4 pm.
To receive this rate, show your membership card
or event ticket when exiting the garage.