Even for those of us long past our school years, fall always feels like “back to school”—a time for new ventures and new adventures. The most exciting new venture at the Museum is our Master of Arts in Teaching (MAT) program, which marks the first time that an institution other than a university or college will offer a master’s program for science teachers. Please read more about this pioneering initiative on page 3.

Fall 2011 brings a full slate of exciting offerings for public, including our thrilling new exhibition, Beyond Planet Earth: The Future of Space Exploration; perennial favorite The Butterfly Conservatory; and the 37th anniversary of the Margaret Mead Film Festival. The fall also brings important changes to the Membership program. Last year, in an effort to learn more about your needs and interests, the Museum conducted a comprehensive study, in which many of you participated. Based on that work, the Museum has restructured and enhanced its program to bring it more fully in line with Members’ lives. Membership categories will now more closely reflect the kinds of households that you are part of, with new Family and Adult tracks that will allow us to tailor programs, services, and benefits.

Rotunda / Fall 2011 / AMNH.org

Statement of ownership, management, and circulation.
Title of Publication: Rotunda (ISSN: 0194-6110; USPS 622-600). Date of filing: August 2, 2011. Frequency of issue: Quarterly. Number of issues published annually: 4. Annual subscription price: Museum membership of $70 a year or higher. Contact the Membership Office to obtain address of known office of publication: 15 West 77th Street, New York, NY 10024-5192. Phone: 212-769-5906. Website: amnh.org. Museum membership of $70 per year and higher includes a subscription to Rotunda. C.201 American Museum of Natural History. Periodical postage paid at New York, NY, and at additional mailing offices. Postmaster: please send address changes to Rotunda, Membership Office, AMNH, at the above address. Please send questions, ideas, and feedback to rotunda@amnh.org.

For more about the Museum’s MAT program, visit amnh.org/education/mat.
The ponyfish does not produce its own light but instead relies on its resident population of Photobacterium leiognathi, a luminous marine bacterium that lives in its light organ. The relationship between the two is mutually beneficial: the ponyfish provides the bacteria with oxygen and nutrients, and the bacteria give their host the ability to use light displays.

**An Abundance of Fishes**

The size of the Museum’s ichthyology collection, which includes some 2 million specimens housed in four floors of two adjacent buildings, is rapidly growing and ranks fourth among the eight major international centers for ichthyology.

**Tools for Study**

Spark’s research into the evolution and function of bioluminescent signaling systems in fishes is supported by two National Science Foundation grants. As part of these projects, he is collaborating with colleagues at other institutions to develop, refine, and implement 3-D magnetic resonance imaging (MRI) technology for analyzing soft tissue structures in bioluminescent marine fishes, hearing mechanisms in cichlids, and brain development in freshwater and marine fishes.

**MIF at the Museum**

The Museum’s Microscopy and Imaging Facility offers scientists a range of state-of-the-art technologies for research. Among the sophisticated equipment is a high-powered computerized tomography (CT) scanner, one of only four of its kind in the country; a scanning electron microscope, which can magnify images up to 500,000 times; and a confocal laser scanning microscope, which provides 3-D images in microscopic detail.

**Safeguarding Specimens**

In addition to offering a window into previously unseen phenomena, advanced instruments—such as the electron microscope that reveals mineral composition of meteorites—provide another significant benefit: they leave valuable specimens intact.

**Brain Case: Diplodocus longus**

In a corner of the exhibition The World’s Largest Dinosaurs, an elegant wire outline of the head of Diplodocus longus, a sauropod that lived in the Late Jurassic period about 156 million years ago, anchors a fascinating fossil—one half of a bony braincase, its interior carefully color-coded to denote various functional structures once within it.

One’s first impression is how very small the brain must have been, especially given that the brain itself probably took up only about 70 percent of the bony case, with protective outer layers called meninges taking up the other 30 percent. Despite the dinosaur’s massive size—its body stretched 40 feet long and weighed 20,000 pounds—its brain weighed about 4 ounces. By comparison, the average adult human brain weighs 48 ounces.

Of course, scientists can only speculate about this because brains—composed mostly of water—don’t fossilize well and are extremely rare, almost nonexistent, within the fossil record.

“It’s informed guesswork,” says Jonah Choiniere, a postdoctoral fellow in the Division of Paleontology. “We’re extrapolating based on comparative data from living animals such as birds and crocodiles.”

Through the brain itself is lost forever, the endocast, or cavity within the braincase, offers valuable clues to the dinosaur’s basic functions, metabolism, and lifestyle. In the exhibition display, four key structures are identified with different colors: the optical nerve opening (green), the facial nerve opening (orange); the pineal opening (yellow), and the site of the pituitary gland (blue).

“This particular specimen was chosen for this exhibition because it has been delicately prepared and sectioned to expose the brain cavity,” says Mark A. Norell, chair of the Division of Paleontology and curator of The World’s Largest Dinosaurs. “Only rarely are sauropod dinosaur skulls found with the braincase relatively intact and undistorted.”

Color-coding the braincase for the current special exhibition involved a process designed to be fully reversible. First, preparators covered the interior with a series of chemical dyes: red for tinting bones, blue for cartilage, and enzymes to make tissues transparent. Photos of the treated fish—including those pictured above—were used in conjunction with photographs of the treated tissue to create a color-coded model of the braincase. Then, they applied acrylic paint, which can be peeled off the plastic base that in turn can be removed with acetone, a solvent familiar to anyone who has ever used nail polish remover.

**The World’s Largest Dinosaurs, which is free for Members, closes on January 2.**

**Cleared and Stained: Picturing a Ponyfish**

While advances in imaging technologies have opened new pathways for scientists to study natural phenomena, researchers continue to make remarkable discoveries using techniques that have been around for decades. John Sparks, associate curator in the Museum’s Department of Ichthyology, uses enzymes and dyes to reveal key anatomical structures in different species of fishes for study of their function and evolution.

Among his study subjects are ponyfishes (family Leiognathidae), a group of bioluminescent fishes common in the Indian Ocean and Western Pacific that have a light organ. This internal structure, which varies among ponyfish species, surrounds the esophagus and contains luminous bacteria, the source of the fish’s light. The light organ is larger in males, which have a second species-specific anatomical feature: translucent skin patches, which allow them to use the light organ in displays to attract mates in turbid waters. (Bioluminescent organisms will be explored in the exciting new exhibit Creatures of Light: Nature’s Bioluminescence, which opens at the Museum in Spring 2012.)

In expeditions to Madagascar, Taiwan, South and Southeast Asia, and other sites, Sparks and his colleagues have collected thousands of specimens, including the Senator runnioni pictured above. Back in the laboratory, Sparks treats the fish with a series of chemical dyes: red for tinting bones, blue for cartilage, and enzymes to make tissues transparent. Photos of the treated fish—including those featured in the exhibition Picturing Science: Museum Scientists and Imaging Technologies—show the whole body with inner organs intact in strikingly colored images that illuminate structural differences.

Sparks is using this technique, in combination with 3-D imaging, DNA analysis, and other methods, to compare the light organs of different ponyfish species and gain insight into the evolution of light-signaling systems, the role of sexual selection in ponyfish diversification, and co-evolution of the fish and the luminous bacteria abundant in its light organ.

**Picturing Science: Museum Scientists and Imaging Technologies is on view in the Akeley Gallery. This exhibition is made possible by the generosity of the Arthur Ross Foundation.**

**American Museum of Natural History**

**Original Fossil**

The Diplodocus longus braincase was discovered on a Museum expedition in 1901 at Bone Cabin Quarry, Wyoming. The other half is on permanent display in the Hall of Saurischian Dinosaurs in the David H. Koch Dinosaur Wing. Today, such a find would be studied with a CT scanner, eliminating the need to bisect it with a rock saw to see what’s inside.

**By the Dozen**

With the exception of frogs and salamanders, all four-limbed animals, including humans, have 12 cranial nerves that are involved in everything from small (olfactory) to heart rate (vagus). This commonality helps scientists make sense of what they see when studying the empty braincases of extinct animals.

**Breathing Room**

Some scientists speculated that D. longus had a trunk because of the location of the bony nasal opening high on the skull between the eye sockets, akin to today’s elephants and tapirs. But recent research on the tiny opening for the facial nerve—at most, 1.5 mm in diameter compared to half of an inch for an elephant—suggests that the animal lied the wiring to power the muscles needed for a trunk.

**Cold Case**

Sometimes called “the third eye,” the pineal opening at the apex of the skull is found in some extinct and a few extant tetrapods, notably the tuatara, a lizardlike reptile in New Zealand. In living animals, it is thought to play a role in detecting light, which may help regulate circadian rhythms and body heat. Its function in saururoids like Diplodocus remains a mystery.

**Growth Factor**

The pituitary gland secretes hormones that influence an animal’s body size. In humans, the pituitary is the size of a pea, or about 0.2 percent of brain volume. In D. longus, the pituitary was roughly 10 percent of the brain volume. Quite simply, says Choiniere, “This tells us it was a giant!”
We humans are barely toddlers when it comes to space exploration. Our first baby steps off our home planet 50 years ago took us to low Earth orbit. By 1975, 12 interred men had walked on the moon’s surface. Since then we have sent robots to every planet in our solar system. The Hubble Space Telescope has shown us that the ordinariness matter we are made of comprises only 4 percent of the mass of the universe. The Kepler orbiting telescope has proved that billions of worlds orbit the stars of our Milky Way galaxy. What will we accomplish in space in coming centuries, as our steps become surer and bolder?

The new exhibition Beyond Planet Earth: The Future of Space Exploration takes you on the adventures awaiting humanity in the next few hundred years. Suborbital tourism, deflecting asteroids, establishing lunar and Martian scientific bases, terraforming Mars, and searching for life in Europa’s oceans will all happen in the coming century. While we can’t predict what the spaceships carrying us and our robots will look like, we do know where we’re going, the challenges of getting there, and the opportunities available when we arrive at destinations as alien as anything out of “Star Trek.”

The cover of this issue of Rotunda shows what a lunar base at the South Pole of the Moon might look like. The South Pole is a likely place for a lunar base for two reasons. First, there’s probably a lot of frozen water there; from comets that crashed there and remained frozen in nearly perpetual darkness. Just as important, the Sun is almost continuously visible from the top of the rims of South Pole craters, so that large arrays of solar panels could continuously supply power to a lunar base. A huge infrared-ultraviolet telescope, larger than a football field and with a rotating liquid mirror, would capture images of celestial objects with a resolution unmatched even by Hubble or Webb.

The Moon’s South Pole would also be a logical base for a lunar elevator, shown at left with its cable stretching back to Earth. This invention: A real lunar elevator for moving people and cargo such as helium-3, a rare isotope found in lunar soil that is thought to be a clean candidate for nuclear fuel, to and from the Moon could be built with current technologies and materials. (Visitors will see a model of a lunar elevator in the exhibition.)

The principle of a lunar elevator is elegant and simple. Any object—let’s say a space station—placed along a line joining the centers of the Moon and the Earth, and more than one-ninth the distance from the Moon to the Earth, will fall toward Earth. That’s because Earth is 81 times as massive as the Moon, so its gravitational pull exceeds that of the Moon as soon as you travel more than 26,500 miles toward Earth from the Moon. If you attach a cable from the lunar surface to the space station, the station is tethered; it “wants” to fall toward Earth because of Earth’s dominant gravity, but it can’t because it’s held in place by the cable. Voilà: you’ve just built lunar-Jack’s beanstalk pointing up to Earth from the lunar equator. Now imagine extending the cable 255,000 miles, to just above the Earth’s atmosphere. Attach gripping, rotating wheels to the mechanical arm of a solar-powered gondola connected to the cable, and you have a rocket-free way of transporting anything and anybody between the Earth and the Moon’s surface.

Well, almost. You do have to “jump” to about 100 miles above the Earth’s surface to catch the gondola as it moves by at 1,000 miles per hour due to the Earth’s speed of rotation. But rocket-airplanes suitable for this purpose are already being built by commercial companies like Virgin Galactic. One of the great advantages of this scheme is that you never need to speed up, or slow down from, Earth-orbital speed of 17,500 miles per hour. Thus the dangerous heating and mechanical stresses generated when reentering Earth’s atmosphere would be hundreds of times less on a rocket-plane-lunar elevator trip to the Moon than a trip involving rockets. A one-way trip would take about a week and could be as comfortable as an Alaskan or Caribbean cruise, though somewhat more expensive. Tourism could help support the operation of a lunar elevator.

The lunar elevator also offers the opportunity for the most extreme sport I can think of: space jumping. If you stepped off the end of a cable stretching down from the tethered space station to about 60 miles above the Earth—in a space suit, of course—you would begin to fall faster and faster. Reaching about 2,500 miles per hour when you began to encounter the outer atmosphere, you would use a combination of carefully timed drogue parachutes, a parasail, and a main parachute to slow down enough to avoid being torn apart by wind resistance. If you were really good, and lucky, you might land safely within a 100 yard bird’s-eye—just 15 minutes after you left space.
As rain streams down the suspended glass curtain of the Rose Center for Earth and Space, the Museum is a cocoon of stillness save for the strains of music coming from a row of windows high above the Hayden Sphere.

Up on the fifth floor, astrophysicists maintain a furious working pace during their night shift. Galileo supervises from a gilt frame on the wall; bronze busts of Einstein and Copernicus wear Yankee and Mets caps. Laptops fill a long wooden table: one scientist checks coordinates, one projects black and white splotches onto a screen, and one communicates with a telescope operator in Hawaii, where clear skies open a window onto distant stars. Every two minutes the team remotely targets a new potential supernova.

“The whole point is to find all stars in the Milky Way that are going to explode as massive Type Ib and Ic supernovae [which occur when a massive star’s core collapses] over the next 500,000 years,” says Michael Shara, curator in the Museum’s Department of Astrophysics, as he glances up from his computer. “We think there are about 6,000 of them, and we are picking them out from the other billions of stars in the galaxy to measure their spectra—to collect a frozen tissue sample, if you will.”

Shara, who is also curator of the new exhibition Beyond Planet Earth: The Future of Space Exploration, which opens November 19, is one of three curators in the Department of Astrophysics, which includes theorist Mordecai-Mark Mac Low, who simulates star and planet formation, and Ben Oppenheimer, who images planets that orbit distant stars. Together, these curators lead a research group of two dozen graduate students, research scientists, and postdocs who peer into the cosmos from 81st Street.
Studying Massive Supernovas
Curator Shara studies stellar populations in the Milky Way and nearby galaxies. Over the last decade, he has focused on stars known as Wolf-Rayets—hottest, ephemeral objects that start their lives 20 to 80 times more massive than the Sun and then shed much of that mass over a lifespan of a few hundred thousand years until they explode as Type Ibc or Ic supernovae. There are now 600 Wolf-Rayet stars known in the Milky Way, an 80 percent increase since 2006. Shara’s team has found and characterized the majority of them. His “best” and rarest specimens are from the far side of the Milky Way, which is still terra incognita to astronomers.

“There is no question supernovae occur on average every 50 to 100 years in the Milky Way,” says Shara. “Astrophysicists detected two dozen neutrinos from a supernova in the Large Magellanic Cloud in 1987, but a supernova in our galaxy would be invaluable because it would be only about 10,000 light years away and hundreds of times brighter. In addition, we can now measure gravity waves—the rattling of space-time—as well as neutrinos, and that would help us understand the collapse of a star’s core into a black hole as it becomes a supernova.”

Shara is increasing his odds of finding massive supernovae by also looking for Wolf-Rayet stars in Messier 101, a spiral galaxy 100 times farther away, or 10 million light years from Earth. Using the Hubble Space Telescope, Shara has gathered a list of candidates by imaging the galaxy through an optical filter that transmits only the light of ionized helium—where Wolf-Rayet stars shine brightest. These candidates will be investigated further by colleagues working on the 10-meter Gemini telescope in Hawaii. So far, Messier 101 seems to be four to five times more supernova-rich than the Milky Way. Shara just might get his wish of “seeing” a massive supernova erupt in his lifetime.

Modeling Cosmic Evolution
Curator Mac Low’s office is bright, and most of the floor space is claimed by book-lined shelves and neat stacks of papers. Just outside the door, the hall window—marked with equations scribbled in red and blue marker—looks out onto the grey top of the Hayden Sphere as sunlight pours in from 81st Street.

Mac Low also studies the evolution of stars, but his more theoretical approach to astrophysics requires months of computing time and routine digital conference calls with an international network of collaborators and students.

“I am a storyteller,” says Mac Low. “I am verbally oriented, not primarily a mathematician, but getting a computer to do what you want it to do is something that I am comfortable with and amused by, by and large.”

One story that Mac Low likes to tell is how stars form. Until he began working on this problem a decade ago, most astrophysicists’ models of star formation were based on the assumption of an idealized geometric distribution of gas. But when simulations include more realistic turbulent gas flow, it becomes clear that chaotic motions provide stability against gravitational collapse to the gas between the stars, determining the speed with which stars form.

“The simulations we run are, in their essence, the same as programs used for weather prediction,” says Mac Low. “They follow the motions of a gas as it is heated and cooled and pushed around. Over millions of these steps, we follow the gross evolution of a supernova explosion.”

Another story involves a conundrum that has stumped astrophysicists for decades: how do planets—asteroids and dwarf planets—evolve from rocks and boulders in a young solar system whose star is still surrounded by its natal gaseous disk? As the rocks collide and grow larger, they orbit faster than the gas and feel a headwind that drags them into the star. Mac Low and colleagues found the answer in a phenomenon well known to cyclists—drafting behind the leader. If there are more rocks in one orbit, further rocks fall into that orbit are protected from the headwind and can accumulate there. So much material can accumulate that gravity can collapse it together, forming large asteroids and even dwarf planets in only ten or so orbits.

Exploring New “Worlds”
Associate Curator Oppenheimer’s lab on the sixth floor of the Hayden Center is an all-ergen-plagued person’s dream: a room immersed in the drone of pressurized air and purification systems that keep the equipment built and refined here dust-free. Among power drills, metal cutters, and screwdrivers, items with sci-fi names like “supercontinuum laser” and “vacuum chamber” rest on a table that can float on air. On the wall, a line drawing diagrams the test bed for an indispensable tool: the “coronagraph” that mimics an eclipse, allowing astronomers to see distant planets close to a star by eliminating much of the star’s light, the planet’s light.

The clean lab is where delicate, precise instruments are built for Project 1640, one of the few teams in the world working to image planets that orbit stars outside of our solar system, known as exoplanets.

“We image and measure the spectra of exoplanets to determine the chemical composition of their atmospheres,” says Oppenheimer, who leads Project 1640. “This is technically extremely difficult—like trying to see a firefly an inch from a really bright spotlight thousands of miles away—because the planets are billions of times fainter than the stars they orbit.”

Oppenheimer’s team has been testing their Project 1640 equipment over the past few years at Palomar Observatory in California. Improvements allow the team to control the light to the precision of up to one one-thousandth of a wavelength—which is roughly one nanometer, or a billionth of a meter—and to simultaneously measure hundreds of thousands of wavelengths of light from a single spot. “Planets are hiding behind the speckles, but, because they don’t move, we’ve made progress in distinguishing them from what does,” says Oppenheimer. “And we’ve had a few finds along the way, like the new star in the Big Dipper, Alcor B.”

This fall, Oppenheimer’s team begins a three-year survey of hundreds of stars to find new planets and to begin comparative planetary science in earnest. The Project 1640 team is well-placed to discover new planets, since their readiness will allow them to begin making observations about a year ahead of other teams. Interestingly enough, one of those teams, Gemini Planet Imager, includes Oppenheimer as a member. Racing against himself, Oppenheimer will continue to expand our knowledge of the universe—as will his fellow curators, Mac Low and Shara—from the Rose Center and beyond.

Bringing Astrophysics to the Public
Space Shows about stars and the search for life, Astrobotanists that make the latest breakthroughs in astrophysics accessible, blockbuster annual Isaac Asimov Memorial Debates, a digital atlas of the universe to the public. With the opening of the Rose Center for Earth and Space in 2000, Space Shows about stars and the search for life, Astrobotanists that make the latest breakthroughs in astrophysics accessible, blockbuster annual Isaac Asimov Memorial Debates, a digital atlas of the universe to the public.
Later this year, NASA will launch its biggest, most advanced rover yet: the one-ton Curiosity, a mobile laboratory with a two-year mission to find out whether Mars has ever supported life. Beginning with Sojourner, the 23-lb rover sent to Mars in 1997 as part of the Pathfinder mission, Mars rovers have provided scientists with invaluable information about the Red Planet. Now it’s Curiosity’s turn. The rover will carry ten scientific instruments, including a laser to vaporize Martian rock samples to reveal their composition, a set of tools to check for organic compounds in samples of Martian soil and atmosphere, and an instrument to detect ice or hydrated minerals underground.

See a life-sized model of the Curiosity rover in Beyond Planet Earth: The Future of Space Exploration.
Visitors 7 and older can chat unless the program is cancelled rain or shine. There are no refunds.

Meet the Scientist Saturday, October 1

Live Bat Encounter Saturday, October 11

Tickets

Adventures in the Global Kitchen: Beer and Cheese Wednesday, October 19 6:30 pm $30

Green Fire: Aido Leopold and a Land Ethic for Our Time Tuesday, October 11 6:30 pm Free

Join a Museum tour guide for an insider’s introduction to all that the Museum has to offer.

Visitors 7 and older can chat unless the program is cancelled rain or shine. There are no refunds.

Meet the Scientist Saturday, October 1

Live Bat Encounter Saturday, October 11

Tickets

Adventures in the Global Kitchen: Beer and Cheese Wednesday, October 19 6:30 pm $30

Green Fire: Aido Leopold and a Land Ethic for Our Time Tuesday, October 11 6:30 pm Free

Join a Museum tour guide for an insider’s introduction to all that the Museum has to offer.

Visitors 7 and older can chat unless the program is cancelled rain or shine. There are no refunds.

Meet the Scientist Saturday, October 1

Live Bat Encounter Saturday, October 11

Tickets

Adventures in the Global Kitchen: Beer and Cheese Wednesday, October 19 6:30 pm $30

Green Fire: Aido Leopold and a Land Ethic for Our Time Tuesday, October 11 6:30 pm Free

Join a Museum tour guide for an insider’s introduction to all that the Museum has to offer.

Visitors 7 and older can chat unless the program is cancelled rain or shine. There are no refunds.

Meet the Scientist Saturday, October 1

Live Bat Encounter Saturday, October 11

Tickets

Adventures in the Global Kitchen: Beer and Cheese Wednesday, October 19 6:30 pm $30

Green Fire: Aido Leopold and a Land Ethic for Our Time Tuesday, October 11 6:30 pm Free

Join a Museum tour guide for an insider’s introduction to all that the Museum has to offer.

Visitors 7 and older can chat unless the program is cancelled rain or shine. There are no refunds.

Meet the Scientist Saturday, October 1

Live Bat Encounter Saturday, October 11

Tickets

Adventures in the Global Kitchen: Beer and Cheese Wednesday, October 19 6:30 pm $30

Green Fire: Aido Leopold and a Land Ethic for Our Time Tuesday, October 11 6:30 pm Free

Join a Museum tour guide for an insider’s introduction to all that the Museum has to offer.

Visitors 7 and older can chat unless the program is cancelled rain or shine. There are no refunds.

Meet the Scientist Saturday, October 1

Live Bat Encounter Saturday, October 11

Tickets

Adventures in the Global Kitchen: Beer and Cheese Wednesday, October 19 6:30 pm $30

Green Fire: Aido Leopold and a Land Ethic for Our Time Tuesday, October 11 6:30 pm Free

Join a Museum tour guide for an insider’s introduction to all that the Museum has to offer.

Visitors 7 and older can chat unless the program is cancelled rain or shine. There are no refunds.

Meet the Scientist Saturday, October 1

Live Bat Encounter Saturday, October 11

Tickets

Adventures in the Global Kitchen: Beer and Cheese Wednesday, October 19 6:30 pm $30

Green Fire: Aido Leopold and a Land Ethic for Our Time Tuesday, October 11 6:30 pm Free

Join a Museum tour guide for an insider’s introduction to all that the Museum has to offer.

Visitors 7 and older can chat unless the program is cancelled rain or shine. There are no refunds.

Meet the Scientist Saturday, October 1

Live Bat Encounter Saturday, October 11

Tickets

Adventures in the Global Kitchen: Beer and Cheese Wednesday, October 19 6:30 pm $30

Green Fire: Aido Leopold and a Land Ethic for Our Time Tuesday, October 11 6:30 pm Free

Join a Museum tour guide for an insider’s introduction to all that the Museum has to offer.
Don’t Miss

Young Naturalist Awards
Submissions due Friday, March 9
This annual research-based science competition recognizes students in grades 7 through 12 who carry out scientific investigations in biology, Earth science, ecology, and astronomy. Submissions are reviewed by a panel that includes environmentalists, science teachers, and Museum scientists, and two winners are chosen from each grade level. For more information, visit amnh.org/gya.

Whale Watch Weekend
Friday, May 18–Sunday, May 20
$300 per person, double occupancy
$400 single occupancy
Please register before May 1
Join this weekend excursion to Provincetown with Museum educator Jay Holmes to enjoy two private whale watch excursions, explore the dunes, take a guided bird walk, and more. Cost includes transportation by private coach, meals at the hotel, two boat excursions, dinner tour, admissions, and lodging for two nights. The program is limited to 42 Members.

Credits
The Museum’s Youth Initiatives are generously supported by
the leadership contribution of the New York Life Foundation.
Public programs are made possible, in part, by the Rita and Friz Markus Fund for the Public Understanding of Science.
MiloLife Foundation is the Presenting Sponsor of the Museum’s multi-cultural public programming.
Popular Science is the media partner for Hayden Planetarium monthly astronomy programs and lectures.

SciCafe is proudly sponsored by Judy and Josh Weston.
SciCafe is made possible by a Science Education Partnership Award (SEPA) grant from the National Center for Research Resources (NCRR), a component of the National Institutes of Health (NIH).
The Young Naturalist Awards are proudly supported by Aviva Foundation.

Made possible through the generous sponsorship of Lockheed Martin.
And proudly sponsored by Accenture.
Supercomputing resources provided by the Texas Advanced Computing Center (TACC) at The University of Texas at Austin, through the TenGrid, a project of the National Science Foundation.

Frogs: A Chorus of Colors is presented with appreciation to Clyde Peeling’s Reptiland.

Picturing Science is made possible by the generosity of the Arthur Ross Foundation.

Journey to the Stars was developed by the American Museum of Natural History in collaboration with the California Academy of Sciences, San Francisco; GOTO JC, Tokyo, Japan; Populite Museo de Anejo, Mexico City, Mexico; and Smithsonian National Air and Space Museum, Washington, D.C.

Journey to the Stars was created by the American Museum of Natural History with the major support and partnership of NASA, Science Mission Directorate, Heliophysics Division.

The World’s Largest Dinosaurs is organized by the American Museum of Natural History; New York (www.amnh.org) in collaboration with Sístole, S.A., Bogotá, Colombia.
The World’s Largest Dinosaurs is proudly supported by Bank of America.

Additional support is generously provided by Marshall Fund Rachael C. Levine, and Drs. Marla B. and Natasha Levine.
Margaret Mead Film Festival at 35: Celebrating a Legacy and Looking Forward

“One of the many unique things about the Mead is the robust conversations after the screening with not only the filmmaker but the film subjects and people who are researching the topics of our films,” says Ariella Ben-Dov, artistic and festival director. “People enter into a dialogue about the regions, the topics, the human beings, the cultures, the traditions.”

This year’s festival will include conversations with Anne Makepeace and Jessie Little Doe Baird, filmmaker and subject, respectively, of We Still Live Here, the story of an extraordinary Wampanoag speaker in seven generations. Last year Baird received a MacArthur Fellowship, more commonly known as the “genius” grant, for her role in reclaiming a long-silent indigenous language.

“The Mead was an innovator in utilizing film and ethnography to showcase the diversity of culture across the globe for American audiences,” says Ruth Cohen, director of the Museum’s Center for Lifelong Learning. “Today, with features such as We Still Live Here, the festival provides a uniquely deep and expansive cultural experience for its audiences.”

“We Still Live Here exemplifies another important aspect of the Mead Film Festival: an emphasis on native voices. “The Mead really champions work about cultures,” says Ben-Dov. “These films transport audiences. They are the vehicles through which audiences,” says Ariella Ben-Dov, artistic and festival director. “People enter into a dialogue about the regions, the topics, the human beings, the cultures, the traditions.”

The Margaret Mead Film Festival runs from November 10 through November 19. Visit amnh.org/mead for additional details.

MetLife Foundation is the Presenting Sponsor of the Museum’s multicultural public programming.

Museum Scientist Named to NASA’s 2016 Mission to Asteroid

“Sample return sets the highest standard for unmanned missions beyond Earth, because samples ‘keep on giving’ as we develop better instrumentation in our laboratories,” says Denton Ebel, associate curator in the Department of Earth and Planetary Sciences at the Museum. “Samples can be returned to over and over again as new questions are raised and new ideas are proposed. For example, the Museum houses a large collection of asteroid samples, the meteorites. In this case we will know the exact source, and the samples will be unaffected by entry into Earth’s atmosphere.”

In addition to collecting samples, OSIRIS-REx will gather data to help scientists better understand 1999 RQ16 and its four-year journey to its destination. After OSIRIS-REx performs surface mapping of the asteroid—a process that may take up to 505 days—Connolly will be responsible for recommending locations most suitable for sampling.

“We will narrow it down to several choices to select the best location based on low risk to the spacecraft and on chemical signatures” found during surface mapping, says Connolly, who is also professor of Earth and Planetary Sciences at the City University of New York.

The spacecraft will use a robotic arm to collect at least 60 grams of material, which will be brought to Earth in 2023 for worldwide distribution for study. As mission sample scientist, Connolly will prepare the plans that specifies which researchers will receive material for analysis. In advance of the launch, Connolly will be helping to coordinate and integrate studies of the asteroids, their spectroscopy and geology, which will draw on data from ground-based observations of 1999 RQ16 and reference meteorites, including specimens in the Museum’s collection.

Asteroids, which contain original material from the solar nebula that gave rise to our solar system more than 4.5 million years ago, yield important clues about the formation of the solar system and planets. OSIRIS-REx aims to bring back pristine samples for study.

“Sample return sets the highest standard for unmanned missions beyond Earth, because samples ‘keep on giving’ as we develop better instrumentation in our laboratories,” says Denton Ebel, associate curator in the Department of Earth and Planetary Sciences at the Museum. “Samples can be returned to over and over again as new questions are raised and new ideas are proposed. For example, the Museum houses a large collection of asteroid samples, the meteorites. In this case we will know the exact source, and the samples will be unaffected by entry into Earth’s atmosphere.”

Geologist Harold C. Connolly, a research associate in the Museum’s Department of Earth and Planetary Sciences, will oversee sample analysis on the first U.S. mission to collect material from an asteroid and bring it to Earth for study. "We will narrow it down to several choices to select the best location based on low risk to the spacecraft and on chemical signatures” found during surface mapping, says Connolly, who is also professor of Earth and Planetary Sciences at the City University of New York.

The spacecraft will use a robotic arm to collect at least 60 grams of material, which will be brought to Earth in 2023 for worldwide distribution for study. As mission sample scientist, Connolly will prepare the plans that specifies which researchers will receive material for analysis. In advance of the launch, Connolly will be helping to coordinate and integrate studies of the asteroids, their spectroscopy and geology, which will draw on data from ground-based observations of 1999 RQ16 and reference meteorites, including specimens in the Museum’s collection.

Asteroids, which contain original material from the solar nebula that gave rise to our solar system more than 4.5 million years ago, yield important clues about the formation of the solar system and planets. OSIRIS-REx aims to bring back pristine samples for study.

“Sample return sets the highest standard for unmanned missions beyond Earth, because samples ‘keep on giving’ as we develop better instrumentation in our laboratories,” says Denton Ebel, associate curator in the Department of Earth and Planetary Sciences at the Museum. “Samples can be returned to over and over again as new questions are raised and new ideas are proposed. For example, the Museum houses a large collection of asteroid samples, the meteorites. In this case we will know the exact source, and the samples will be unaffected by entry into Earth’s atmosphere.”

“Sample return sets the highest standard for unmanned missions beyond Earth.”

In late January, astrobiologist Michael Shara, curator of the new exhibition Beyond Planet Earth: The Future of Space Exploration, will lead a nine-day expedition to Hawaii that combines an exploration of the Island’s unique natural history with tours of some of the world’s top astronomical facilities.

Highlights will include visits to Project Pan-STARRS (Panoramic Survey Telescope and Rapid Response System), which surveys the skies for objects on a path to impact the Earth, and to the Mauna Kea Observatory Complex. Home to the twin 10-meter W. M. Keck telescopes, the complex also houses the world’s largest infrared and optical-infrared telescopes, which give this facility the most light-gathering power of any location on Earth.

“Many astronomers feel that Hawaii is as close to heaven as you can get,” says Shara. “The night skies at the summit of Mauna Kea and Mauna Kea draw us back again and again.”

The expedition, from January 21 through January 29, will also include visits to Kilauea Volcano National Park, a whale-watching cruise, and an excursion to the Kohala countryside.

For details, visit amnhexpeditions.org or call 800-486-8687.

An Expedition to Hawaii’s Observatories
Building The Butterfly Conservatory

Now in its fourteenth season at the Museum, The Butterfly Conservatory: Tropical Butterflies Alive in Winter! draws thousands of visitors each year, transporting them to a tropical ecosystem bathed in vivid, live flowers and filled with hundreds of spectacular butterflies and moths. But while the flora and fauna are quite real, the conservatory is the product of careful planning and design by the Museum’s Exhibition Department, which creates a “natural” garden using artificial lighting, precipitation, and climate control.

Manager of Living Exhibits Hazel Davies, who has been involved with the conservatory for more than a decade, and her team start from scratch each year by determining what species to include and “we’ve excited about it,” says George Amato, director of the Museum’s Sackler Institute for Comparative Genomics and the Center for Conservation Genetics, which is responsible for sequencing the big cats’ DNA and analyzing the results. “In terms of scale, it is now the largest project of its kind in the world.”

Collecting more than 5,000 fecal samples so far and sharing the resulting data free of charge to researchers around the world, the Global Felid Conservation Genetics Program follows animals subject to a variety of threats, from diminished habitat to hunting by traders in body parts. For example, compared to more than 100,000 over a century ago, there are fewer than 5,200 tigers in Asia today, occupying only seven percent of their historic range. The research has yielded some good news—a newly identified population of tigers in Laos; more genetic diversity than expected in some areas—but researchers also found that, in a supposedly protected area in Cambodia, one population of tigers had died out.

Like all animals, big cats must breed with unrelated individuals or suffer a loss of genetic variation and the consequences of inbreeding, which weaken and eventually decimate a particular population. Large carnivores, like big cats, require the most space of any species to survive and thrive, a factor that not only puts them at greater risk from human encroachment but also has implications for the potential cascading effects of their disappearance among their respective ecosystems.

By way of example, Amato cites the consequences of the absence of wolves—before they were restored—in Yellowstone National Park. “The whole ecosystem changed,” Amato explains. “There were too many elk. There wasn’t habitat for certain birds. Vegetation changed.”

Sustainable habitats for big cats require safe corridors through which they can roam and access species with whom they can come into contact with each other, says Amato, “because even the largest protected areas are too small to have a genetically healthy population.” Reliable information about the breeding range of the various big cat populations will help conservationists determine which initiatives are likely to succeed.

Following Cats Around the World

The Global Felid Conservation Genetics Program tracks jaguars in Argentina, Belize, Bolivia, Brazil, Costa Rica, French Guiana, Guatemala, Mexico, Paraguay, and Peru; tigers in Bhutan, Cambodia, China, Laos, Myanmar, and Thailand; snow leopards in Afghanistan, China, Kyrgyzstan, Mongolia, Nepal, and Tajikistan; and lions in Gabon and Nigeria.

With the rare exception of lion prides that have become habituated to tourists and filmmakers, big cats are shy, nocturnal, and extremely difficult to observe. Genetic monitoring is a huge leap forward in tracking them compared to trip cameras and satellite tags. For one thing, the collection of fecal samples by field biologists, wildlife officials, and others is non-invasive, with no potential for harming the animals. And the results are much more comprehensive, allowing researchers to identify specific individuals and the relationships within populations—the family members, parents, siblings, and most important for assessing healthy breeding habits, the new offspring of particular pairs. "We’re learning a lot about the natural history of these animals," says Amato, adding a cautionary note, despite the program’s goal to maximize big cats’ chances of survival. “If they don’t persist in the future, how tragic not to learn all we could!”

Five Facts About Moths And Butterflies

Butterflies use a strawlike proboscis to drink nectar and other liquids.

Butterflies don’t eat only nectar. Various species also dine on sap, fruit, and bird droppings. Some are even partial to the sweat on bald human heads.

Moths have a strong sense of smell. Males can detect females a mile away.

Butterflies use a strawlike proboscis to drink nectar and other liquids.

Moths have a strong sense of smell. Males can detect females a mile away.

Bee's Lakatos / AMNH
Save the Date!
Upcoming Events at the Museum

JANUARY
1/4 On Wednesday mornings from January through March, Walk on the Wild Side with Members-only fitness walks followed by breakfast in the Akeley Hall of African Mammals before the Museum opens to the public. Call 212-769-5606 for information.
1/15 Explore the Rose Center for Earth and Space, enjoy live performances, and more at Space Fest from 11 am to 4 pm.

FEBRUARY
2/16 Discover the Museum after hours at Explorer’s Night. Free for Members.

MARCH
3/1 The annual Star Party will include a reception in the Rose Center for Earth and Space, star-gazing on the Arthur Ross Terrace, activities for families, and more. Free for Members at the Voyager and Family Voyager levels and above.
3/8 Dance the night away at the annual Museum Dance, the social event of the season.
3/29 Members will have the first chance to see the exciting new exhibition Creatures of Light: Nature’s Bioluminescence at this exclusive preview. Free for Members.
3/31 Creatures of Light opens to the public.

APRIL
4/19 Go behind the scenes to learn about the latest Museum research at the Member Open House. Free for Members at the Adventurer and Family Adventurer levels and above.
4/25 Join us for the 22nd Annual Environmental Lecture and Luncheon.

Seen at the Museum

1. Renowned paleoanthropologists Richard Leakey and Donald Johanson share the stage at the Museum on May 5 to discuss the overwhelming evidence for evolution in the hominid fossil record.
2. Dr. Johanson, speaking at the May 5 event, discovered the early hominid skeleton known as Lucy.
3. Museum President Ellen Futter spoke to students at the 2011 Urban Advantage Science Days, which was held in the Museum on June 15 and featured research projects by 400 middle school students.
4. Chancellor of the New York City Department of Education Dennis M. Walcott spoke to students, parents, and teachers gathered in Milstein Hall of Ocean Life for the Urban Advantage Science Expo.

Rotunda / fall 2011 / AMNH.org

Photo © AMNH/D. Finnin, photos 2, 3, and 4 © AMNH/R. Mickens
Photos © AMNH/R. Mickens
General Information

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

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% discount.

Museum Shops
The Museum Shop, DinoStore, The Shop for Earth & Space, Cosmic Shop, Brain Shop, Sauropod Shop, and Online Shop (amnhshop.com) offer Members a 10% discount.

Transportation and Parking
Subway: 1 (weekdays) or 6 to 81st Street; 1 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.

Dr. Mark Garlick—an illustrator and astrophysicist—created this moonscape depicting a lunar elevator, a liquid mirror telescope, and a bulldozer mining for helium-3, some of the exciting technologies featured in the new exhibition Beyond Planet Earth: The Future of Space Exploration, which opens November 19.