02 Homegrown Drugs
08 The Symbiotic Secrets of Squids
14 When Beauty Makes Us Sick
18 Evolutionary Ancestor
At Northwestern, researchers study the multifaceted complexity of life through many disciplinary lenses. In this issue of CenterPiece we find researchers analyzing bacteria that colonize ocean-dwelling squid, reading the history of humans from fossils 55 million years old, attacking cancer cells with "naked" nanoparticles, and investigating the relationship between women and their bodies. Their work certainly validates the words of paleontologist Stephen Jay Gould: "Science is not a heartless pursuit of objective information; it is a creative human activity."
CONTENTS

02
Homegrown Drugs
Advancing scientific breakthroughs beyond the lab toward clinical development.

08
The Symbiotic Secrets of Squids
Understanding a bacterium harbored by certain squids leads to a better understanding of the human gut.

12
On the Bookshelf

14
When Beauty Makes Us Sick
Encouraging women to have a better relationship with their bodies.

18
Evolutionary Ancestor

22
Center | Point

Front Cover - The Hawaiian Bobtail Squid goes for a swim inside of its tank. Mark Mandel, microbiology-immunology, studies these tiny mollusks in order to learn more about the bacteria living inside the human gut. Read about Mandel’s research on page 9. Photo used courtesy of The Mandel Lab.
The action of drugs counteracting cancer in the body is often described in terms of warfare. According to Frank Giles, director and founder of the Northwestern Medicine Developmental Therapeutics Institute (NMDTI), this analogy has an unfortunate factual basis.

Some of the original chemotherapy drugs were made based on nitrogen mustard, a close relative of the mustard gas introduced as chemical warfare during World War I.
Like mustard gas, nitrogen mustard was discovered to be a powerful suppressor of blood production. Scientists theorized that an agent that suppressed rapidly growing white blood cells might have a similar effect on cancer cells. Chemotherapy drugs followed.

For that reason among others, Giles, medicine: hematology-oncology, prefers to use the term “therapeutics”—derived from the Greek word for “healing”—rather than drugs and made sure it was part of the name of the institute he developed at Northwestern. NMDTI is one of the latest nodes in the extensive pipeline Northwestern has created to bridge the gaps in drug discovery between laboratory concepts and clinical use—often known as “bench to bedside.” The establishment of the institute has significantly expanded the University’s capability for early-phase clinical trials.

An internationally renowned cancer specialist, Giles has a special interest in the oncology drugs that are one of Northwestern’s active pathways for developing disease therapies and devices. Giles has previously run some of the largest phase I trial programs in the United States, including the Institute for Drug Development at the University of Texas Health Science Center in San Antonio, and was deputy director of the cancer center there.

He has pioneered the use of many agents now used regularly as targeted therapies for cancer patients. Giles also is an attending physician at Northwestern Memorial Hospital with a focus on hematologic malignancies.

Giles explains that therapeutics today can be based on many approaches other than drugs, including viruses and antibodies. “The development of therapeutics is a continuum,” he says. “Cells have different, very sophisticated genetic instructions. Modern techniques can read those instructions.”
Small Solutions
A key component of some of these new technologies is nanotechnology—the science of materials measured in nanometers. Nanotechnology is used in the form of platforms or vehicles for drug delivery as well as therapeutic nanoparticles that easily cross the blood-brain barrier. Among these nanoscale therapeutics are the high-density lipoprotein (HDL) nanoparticles being developed by C. Shad Thaxton, urology, to treat lymphoma, a form of blood cancer involving white blood cells.

Thaxton originally developed the HDL nanoparticles as a therapeutic for cardiovascular disease and also as a potential vehicle for delivering drugs to cancer cells. The particles biologically mimic the size, shape, and surface of the natural high-density lipoproteins found in the blood.

After giving a seminar in 2011 at the Feinberg School of Medicine, Thaxton was approached by Leo Gordon, medicine: hematology-oncology, who asked if it were possible to use HDL nanoparticles to treat lymphoma. The two proceeded to collaborate on this research, investigating why these nanoparticles would kill lymphoma cells and leave healthy cells alone. They found that the nanoparticles by themselves—“naked nanoparticles”—were extremely potent, killing lymphoma cells without any additional drugs because of their ability to modulate cholesterol homeostasis, to regulate equilibrium within the lymphoma cells.

Gordon and Thaxton coauthored a 2013 article in the Journal of the Proceedings of the National Academy of Sciences reporting that synthetic HDL nanoparticles killed B-cell lymphoma—the most common form of the disease—in cultured human cells and inhibited human B-cell lymphoma tumor growth in mice. “The nanoparticles are a potent, targeted therapy,” says Thaxton. “There’s a receptor on the surface of these lymphoma cells that the particles engage. They’re not the only cells in the body that express this receptor, but their expression of it is necessary, but not sufficient, for the particles to cause damage.”

Since coming to a greater understanding of how these nanoparticles work, Thaxton and Gordon have collaborated with Giles to send samples of the nanoparticles to multiple collaborators studying other cancer types, at Northwestern and beyond, to see if there may be other cancers that these particles would engage. “Collaborating with other investigators on something like this—a mechanism of action that is different from most, if not all, cancer drugs—helps grow the momentum behind a new strategy,” says Thaxton.

As a grad student, Thaxton worked with International Institute of Nanotechnology director Chad Mirkin, chemistry, to develop new nanotechnologies. As a result of their collaboration, in 2009 they cofounded AuraSense, a spinout company that uses nanoparticle technology to develop medical therapies and intracellular biomolecule detection assays. AuraSense has worked with Northwestern to license these technologies.

Turning an Idea into a Product
The pipeline for cancer therapeutics is just one example of the drug discovery process at Northwestern. The earlier stages of the process are similar no matter what disease is being treated. “All our invention disclosures go through Northwestern’s Innovation and New Ventures Office (INVO),” says Thaxton. “The INVO staff works on the patenting while the intellectual property is still at Northwestern. And they work with us to license the technology under the right circumstances.”

Michael Moore, INVO invention manager, has worked with Thaxton on a number of projects, including co-teaching a licensing and intellectual property seminar in the Responsible Conduct of Research program. He defines his job as working to minimize innovation’s inherent risk to make
potential partners comfortable with the opportunities. “It’s not always easy,” he says. “Part of the difficulty of innovation is getting alignment between science, business, and the legal reality of the U.S. Patent Office.”

His job often starts with working with a faculty member to get the innovation patented. “Patentability isn’t a reflection of how good the science is,” says Moore. “The Patent Office applies rules of patent law to an application, as opposed to a scientist’s perspective of the merit of an invention.”

Moore stresses that not every innovation is patentable. “Identifying an enzyme to inhibit, for example, might be an amazing discovery, but that’s not an invention,” he says. “An invention is a customizable solution to a problem.” He evaluates inventions as to what could work as a product and then concentrates on finding a commercial partner to invest the necessary funds for bringing that invention to market.

The process of applying for and receiving a patent can be a lengthy one, often lasting five years or more. Interested industrial partners can get involved at any stage during the discovery process and even during the patent process, although without patent protection the invention is not as valuable.

“The investment in a potential drug is considerable,” he says. “It’s a long-term commitment on the part of the industrial partner, who also is committing personnel and possibly disrupting in-house priorities.” Industry experts estimate that for a major pharmaceutical company the cost of creating a new drug is now $5 billion dollars. According to Forbes in 2013, one reason for this is that 95 percent of the experimental medicines that are studied in humans fail to be both effective and safe.

Lyrica, the drug developed from the pregabalin compound discovered by Richard Silverman, chemistry, has skyrocketed Northwestern’s licensing income to exceed that of any other U.S. university since 2007. “Lyrica is a blessing but it can create expectation management issues,” says Moore. “It is an oddity in that it became so successful when so few discoveries do.” He believes, however, that most faculty members, including Silverman, are motivated
not so much by possible revenue but to be useful to society by bringing out products that help patients or solve societal problems.

**Guidance from Experts**

Faculty who are interested in taking their laboratory discoveries through the complex pathway to possible commercialization don’t have to do it on their own. In 2009 Northwestern entrepreneur-in-residence Andrew Mazar, molecular biosciences, joined with Thomas P. O’Halloran, chemistry, to create the Center for Developmental Therapeutics (CDT) within the Chemistry of Life Processes Institute (CLP) to mentor and collaborate with faculty interested in discovering and developing new drugs. Mazar, an experienced biotech entrepreneur who has advanced molecules from the laboratory to phase II clinical trials, serves as CDT director; O’Halloran directs CLP.

In collaboration with Northwestern faculty, CDT is currently working on approximately 40 new therapeutic projects. One of the farthest advanced is a homegrown drug—8-Cl-Adenosine—that Mazar has been developing with Nancy Krett, Robert H. Lurie Comprehensive Cancer Center, and Steven Rosen, former director of the Lurie Cancer Center.

“We’ve manufactured the drug product, now we’re moving forward through the Investigational New Drug application,” says Mazar. “This will be the first one we take into clinical trials where the studies have been managed entirely within the University.”

Mazar works closely with INVO, NMDTI, and the Northwestern University Clinical and Translational Sciences Institute (NUCATS) to expedite the movement of Northwestern’s homegrown drugs from discovery through clinical trials. “Northwestern is one of the few US universities with the capability to pursue this vertically integrated drug discovery and development process,” says Mazar.

CLP–aptly located in the Richard and Barbara Silverman Hall for Molecular Therapeutics and Diagnostics—offers space and administrative support for faculty working on drug discoveries. In addition, CLP provides pilot grants, seed funding, salary support, and core equipment and facilities.

Northwestern’s shared and core facilities provide up-to-date instrumentation and expertise to help faculty with the requisite testing for preclinical work needed in developing therapeutics. For example, CDT and its associated Developmental Therapeutics Core can provide Patient-Derived-Xenograft models for preclinical in vivo testing of anticancer compounds, creating PDX tumor models from human tissue. The human issue is grown into tumors in animal subjects. Such animal models allow more comprehensive testing of new therapeutics than petri dish-based studies. More than a dozen such tumor models have been developed, with more on the way from clinicians at the Lurie Cancer Center.

**Searching for the Ones that Work**

Another University research center, the Center for Molecular Innovation and Drug Discovery (CMIDD), brings together biologists with medicinal chemists to work on the next generation of therapeutics. Co-directed by Karl Scheidt, chemistry, and Raymond Bergan, medicine: hematology-oncology, CMIDD provides investigators with expertise in assay development, screen, hit-to-lead chemistry, cheminformatics, and compound purification—all the resources needed for successful early discovery projects.

“We leverage computational resources whenever we can to streamline the discovery process,” says Scheidt. “We call it testing ‘in silico’ (using a computer).” Using CMIDD’s extensive libraries of molecules as well as advanced software for molecular modeling and computational drug design, researchers can identify their targets at the basic science level and then can manipulate, intercept, and enhance molecules in the
search for mechanisms to block disease processes. Incorporating this process into academic drug discovery research projects provides CMIDD the opportunity with CDT and NMDTI to advance scientific breakthroughs beyond the lab toward clinical development.

For Thaxton, who repeatedly works through this process, it's all worth it. “The process is huge, it’s expensive, it’s exhausting, it takes forever, and you can forget about what you’re doing and why you’re doing it,” he says. “But saving lives, down the road—that would be great.”

— Joan Naper

Good Manufacturing Practices at Northwestern

Good manufacturing practices (GMP) are stringent, federally legislated regulations enforced by the United States Food and Drug Administration (FDA) to maintain the quality of drugs or food products used and ingested by animals and human beings. The testing standards involve determining whether the product or sample has met manufacturing specifications; to meet that requirement, the process must also comply with Good Laboratory Practices (GLP) regulations (not to be confused with laboratory safety standards).

Adhering to strict GMP and GLP guidelines is a crucial mission at the Mathews Center for Cellular Therapy (MCCT), a research facility at Northwestern Memorial Hospital. The MCCT quality control unit has the responsibility and authority to approve or reject all procedures and aspects of testing and manufacturing in accordance with FDA requirements.

“We operate four product manufacturing suites under GMP that can be adapted to most biologic and cellular processes for phase I through phase III clinical trials,” says MCCT director Ann LeFever. “Mostly we have focused on cellular manufacturing—modifying cells to increase or enhance their functions to make them effective therapeutic products.”

In February, LeFever received the good news that regulatory T cells (immune suppressor cells used to provide operational tolerance and prevent organ rejection or Tregs) had received FDA approval—a necessary step in developing a biological therapeutic. At MCCT, Tregs are isolated from patients’ own blood and expanded. The therapeutic use of these cells in living donor kidney transplantation was developed by the Comprehensive Transplant Center’s Joe Leventhal, surgery: transplant surgery, whose team can now begin a clinical trial.

The MCCT was designed and constructed to be compliant for many types of GMP manufacturing processes. Although initially focused on biological, clinical-grade manufacturing, GMP suites have the infrastructure to provide compliant facilities for certain device manufacturing or for the production of combo-products (a device combined with a biological product). Additional support services available through MCCT include quality system oversight, product regulatory development plans, and GMP/GLP logistics and training for facility users.
Mark Mandel wades through Hawaii’s moonlit coastal waters. Using underwater flashlights, he and his research team scan the shallows for the smallest of mollusks. The Hawaiian bobtail squid, which is just over an inch long when fully grown, shakes off sand and swims on a nighttime prowl for shrimp, mosquitofish, and prawns. Mandel and his team are poised—ready to scoop up the tiny squid with a net. On a good trip he collects two dozen, which will produce more than 1,000 eggs in his lab.
Mandel, microbiology-immunology, has devoted his career to studying this small invertebrate—for a surprising reason. By better understanding the bacterium colonizing the squid, he hopes to learn more about the ecosystem of microbiota living inside the human gut.

Symbiotic Specificity
Shortly after hatching, the Hawaiian bobtail squid’s light organ is colonized by one—and only one—type of bacteria, *Vibrio fischeri*. The two species live together in a symbiotic relationship, with the squid providing the bacteria with food and protection and the bacteria providing the squid with luminescence for camouflage. Collecting in the light organ on the squid’s underbelly, the bacteria glow as the squid hunts at night. To potential predators swimming below, the luminous squid blends in with the moonlight and passes safely overhead.

“Every milliliter of ocean water has a million bacteria,” Mandel says. “Yet over the course of a couple days, the squid is colonized by only one type and not the million wrong ones.”

Mandel notes the similarities with humans. When we are born, we are colonized by environmental bacteria. These “good” bacteria help us fully digest carbohydrates, fortify our immune systems, and promote healthy digestion; we are not colonized by pathogens or superfluous bacteria that would do nothing but take up valuable space. “There has to be a process by which we don’t get colonized willy-nilly,” Mandel says.

Mammals tend to have hundreds or thousands of bacterial species, creating a system that’s too complex to tackle. Because the Hawaiian bobtail squid is one of very few creatures with this binary, one-to-one relationship with a single bacterium, that relationship is simpler to study.

Seeing the Light
In the Morton Building on the Chicago campus, a network of tanks is stacked along the walls. Solitary in nature, each squid has a tank to itself, with sand to hide beneath during the day. By squirting bacteria into the water, Mandel can effortlessly colonize new hatchlings. Using confocal microscopy, he watches the bacteria enter the squid and observes the process as it unfolds.

“You can’t actually see the luminescence with the naked eye,” Mandel says. “If it were bright enough for us to see, then it would attract predators.” For this reason Mandel uses a luminometer, a tool offering quick and easy measurements of bioluminescence to determine which squids have been colonized and to what degree.

Communicating Colonies
Previous research has shown that there is a lot of communication between the squid and the bacteria during colonization. *V. fischeri*’s cell walls slough off, signaling to the squid...
that it is the correct type of bacteria. The squid uses appendages to recruit the bacteria into one of the light organ’s six pores. Then those appendages die and fall off, so the squid can no longer enlist new bacteria. \textit{V. fischeri} will live and reproduce inside the light organ for the rest of the squid’s life. When bacteria die, they are flushed out by a means that is not yet understood.

In a recent study, Mandel’s lab flooded an area just outside one of the light organ’s pores with a substance meant to confuse the advancing bacteria. A roadblock was created, and the bacteria never made it inside. The researchers confirmed that \textit{V. fischeri} use a specific molecular source as a signal to swim toward the squid; if the bacteria cannot detect the origin of that source, then they cannot proceed.

“Our interpretation is that the squid is releasing these byproducts,” Mandel says. “But whether this is to attract the bacteria or whether this is another part of its biology, we don’t yet understand.”

\textbf{Preventing Outbreak}

In addition to better understanding the good and bad bacteria that interact with humans, Mandel has another goal: to explore the evolution of highly pathogenic strains. Bacteria constantly mutate and evolve, potentially becoming more dangerous and possibly deadly. With new technology, researchers can view DNA sequences of new strains. But it’s not always clear what makes these new strains better able to colonize or cause disease.

“We hope to understand from our work why evolved bacterial strains have strong differences in their abilities to interact with other animals,” Mandel says.

Very little is known as to when the \textit{V. fischeri}-squid relationship came about or how it evolved. Mandel says it most likely developed within the last 65 million years, but he wants to clarify the timeline. Unfortunately, information is not easy to discover. “Squids are invertebrates,” he says. “They leave lousy fossils.”

— Amanda Morris
The News Gap: When the Information Preferences of the Media and the Public Diverge

Pablo J. Boczkowski, Director of the Program in Media, Technology, and Society

Eugenia Mitchelstein, PhD candidate in the Program in Media, Technology, and Society

MIT Press, 2013

The websites of major media organizations—CNN, USA Today, the Guardian, and others—provide much of today’s publicly consumed online news. But although a large proportion of these sites’ top stories cover politics, international relations, and economics, the sites’ users show a preference (as evidenced by the most viewed stories) for news about sports, crime, entertainment, and weather. In The News Gap Pablo Boczkowski and Eugenia Mitchelstein examine this gap and consider the implications for the media industry and democratic life in the digital age.

The Republic of Rock: Music and Citizenship in the Sixties Counterculture

Michael J. Kramer, history and American studies

Oxford University Press, 2013

The Republic of Rock shows how the musical connections between San Francisco and war-torn Southeast Asia were crucial to the making of the ’60s counterculture. The book also illustrates how and why the legacy of rock music in the ’60s continues to affect the meaning of citizenship in a global society today. Going beyond clichéd narratives about ’60s music, Kramer argues that rock became a way for counterculture participants to think about what it meant to be an American citizen, a world citizen, a citizen-consumer, or a citizen-soldier. The music became a resource for grappling with the nature of democracy in larger systems of American power both domestically and globally.

Public Policy in an Uncertain World: Analysis and Decisions

Charles F. Manski, economics

Harvard University Press, 2013

Public policy advocates routinely assert that “research has shown” a particular policy to be desirable. But how reliable is the analysis in the research they invoke? And how does that analysis affect how policy is made, on issues ranging from vaccination to minimum wage to FDA drug approval? Charles F. Manski argues that current policy is based on untrustworthy analysis. By failing to account for uncertainty in an unpredictable world, policy analysis misleads policy makers with expressions of certitude. Public Policy in an Uncertain World critiques the status quo and offers an innovative approach to improving how policy research is conducted and how policy makers use research.
What Changed When Everything Changed: 9/11 and the Making of National Identity

Joseph Margulies, clinical professor of law and associate director, Roderick MacArthur Justice Center
Yale University Press, 2013

Margulies demonstrates that with regard to key elements of the post-9/11 landscape—especially support for counterterror policies like torture and hostility to Islam—American identity is not only darker than it was before September 11, 2001, but substantially more repressive than it was immediately after the attacks. These repressive attitudes have taken hold even as the terrorist threat has diminished significantly.

Medieval Crossover: Reading the Secular against the Sacred

Barbara Newman, English, religious studies, and classics
University of Notre Dame Press, 2013

The sacred and the secular in medieval literature have too often been perceived as opposites or else relegated to separate but unequal spheres. In Medieval Crossover: Reading the Secular against the Sacred, Barbara Newman offers a new approach to the many ways that the sacred and secular interact in medieval literature, arguing that (in contrast to our own culture) the sacred was the normative, default category against which the secular always had to define itself and establish its niche. Newman refers to this dialectical relationship as “crossover”—not a genre in itself, but a mode of interaction, an openness to the meeting or even merger of sacred and secular in a wide variety of forms.

City Water, City Life: Water and the Infrastructure of Ideas in Urbanizing Philadelphia, Boston, and Chicago

Carl Smith, English and American studies
University of Chicago Press, 2013

A city’s infrastructure is more than just concrete, steel, and grids. Underlying the physical foundations of a city are the ideas and ideals of its planners and developers. Looking specifically at Chicago, Boston, and Philadelphia, Carl Smith reveals in City Water, City Life that how a city provides access to, maintains, and safeguards its water systems speaks volumes about how a city views its citizens and their rights. Questions of democracy, public health, and environmental conservation are intrinsically bound up with the structural realities of urban development.
When Renee Engeln, psychology, first started teaching college undergraduates, she was shocked to overhear their hallway conversations. Instead of discussing coursework or weekend plans, her female students stood around talking about their weight.
“These young women were so accomplished, so funny, so great,” Engeln recalls. “But they would have long conversations about how fat they were.”

These experiences inspired Engeln to study women’s relationships with their bodies. When she joined Northwestern eight years ago, she started the Body and Media Lab, which explores body image and beauty sickness. The lab’s eventual goal is to find interventions that encourage women to have healthy relationships with their bodies.

“From all different angles, we ask what science can do to help,” Engeln says. “How we can help explain what’s going on and determine why it’s going on.”

**Chewing the Fat**

“Fat talk” is a major focus of Engeln’s lab. As demonstrated by her first college students, fat talk is when groups of women talk to each other about how fat they feel. “I’m fat,” one person says. “No, I’m fat,” the next person responds. The conversations continue with statements such as “I’m way fatter.” “My butt looks so big in these jeans” and “I’m too gross to even go outside.” While seeking support usually helps people cope with stress, fat talk actually makes everyone feel worse. The people engaging in the conversations—as well as people who overhear the conversations—end up feeling even more negative about their bodies.

Fat talk starts at age eight or nine and continues in women of all ages. But Engeln—who serves as faculty-in-residence at Allison Residential Community—has found that it is particularly pronounced in college-age women. “About 93 percent of college women say they do it,” she says. “It’s possible that the other 7 percent were lying.”

College women feel harsh pressures to maintain perfect appearances. They are at an age where they date often and seek partners. And they are also in a place where they are trying to form identities and figure out what’s important to them. Many say they learned fat talk from their mothers. But Engeln assumes they did not learn it from their grandmothers. “I think it’s a relatively new phenomenon,” she says. “I don’t think our grandmothers did it.”

While society has always placed value on women’s appearances, older generations were not dealing with today’s fashions. Clothing nowadays leaves little to the imagination. “Over 100 years ago, nobody knew what was going on under that skirt,” Engeln says. “There wasn’t a public discussion of cellulite because cellulite wasn’t a public thing. Things that used to be considered pornographic are mainstream now.”

**Who Wore It Better?**

Social media, such as Facebook and Instagram, have further blurred the
lines between public and private. Women emerge from dressing rooms and talk to the stranger in the next stall about their thighs. On television and in magazines, it’s become fair game to evaluate each other’s bodies. Engeln is particularly concerned about media influences. She says that media tend to do two things: remind women over and over that appearance is the only thing that matters, and urge people to compare themselves to each other to see how they measure up. When it comes to evaluating appearance, women look around at other women. Images of women in the media tend to be vastly unrealistic—unusually thin with flawless skin and perfect hair. “If you compare yourself with a media image,” Engeln says, “you’re almost always going to fall short.”

While being fat does not seem as major a concern for men, they engage in something Engeln calls “body talk.” She says this usually centers around muscle mass. Although men also face unrealistic body ideals in the media, the difference is that they are primarily judged not by appearance but by their competence in the workplace and ability to earn money.

### I (Don’t) Love My Body

Located on Northwestern’s Evanston campus, the Body and Media Lab has conducted several studies to see what can help women feel better about their bodies. Some of these studies have helped Engeln and her colleagues discover what does not work. In one study, women were asked to practice five-minute-long self-affirmations.

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In a recent study, Engeln and her team surveyed 3,066 women of varying ages to learn more about their tendencies to fat talk. She found that as few as 7 percent and as many as 34 percent of survey participants in different groups engaged in fat talk. The women’s BMI categories—whether they were underweight, healthy, overweight, or obese—did have an impact on the frequency of talking about their bodies.

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<th>AGE</th>
<th>% NEVER/RARELY FAT TALK</th>
<th>% FREQUENTLY FAT TALK</th>
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<tr>
<td>16-19</td>
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<td>20-29</td>
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<th>BMI CATEGORY</th>
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<td>Overweight</td>
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Source: Northwestern Body and Media Lab
In one condition, the participating women repeated “I love my body” every time they heard a chime. In the neutral condition, the women stated a fact, such as “I am 19 years old.”

“Thinking ‘I love my body’ made them feel worse about their bodies,” Engeln says. “We found that they would talk back to that idea; they would counterargue it. It actually led them to think about all the reasons they didn’t love their bodies.”

Engeln says the women then felt an added layer of unhappiness: failure for having been unable to love their bodies. “We put women in this strange position,” she explains. “We live in this culture where every message tells you that you’re not good enough. And then we make you feel bad for not having confidence.”

**Compliment Detriment**

Another Body and Media Lab study examined how receiving compliments affects women. Engeln set up a room where two students—one man and one woman—worked to complete a word search task. The male participant was actually a part of the experiment and aware of the study’s aim. At a certain point during the experiment, he was instructed to look at the woman and say: “That shirt looks good on you.” Again, Engeln found that the compliments made the woman feel worse about her body.

“It’s quite possible that she wasn’t thinking about her body at all until she received the compliment,” Engeln says, “It just caused her to think about her appearance more.”

**Power of Distraction**

These studies made Engeln realize that the best thing women can do to feel better about their bodies is not think about them. She advocates that women distract themselves. “When you’re feeling miserable about something that you can’t immediately solve, thinking about it doesn’t help,” she says, “Distraction is really underrated.” She instructs her students to keep a computer file of their favorite Internet videos and photos—things that make them laugh. Whenever they feel bad about themselves, they can open the file to find something they enjoy.

While women cannot control the images in the media, they can control their thinking and the perpetuation of fat talk. When a friend says she feels fat, our instinct is to comfort her and tell her she’s not. But Engeln says the best thing to do for that friend is to change the subject and give her a break from thinking about her body.

Engeln says fat talk leads to beauty sickness, which turns our attention away from everything else in the world. Constantly worrying about weight and appearance serves as a barrier that keeps individuals from engaging with others.

“You actually pay a price when your brain is obsessed with calories and sucking in your stomach,” she says. “People think their brains can multitask and think about all these different things at the same time, but it’s not true. We can’t focus on work and be thinking about how our body looks.”

— Amanda Morris
Ten years ago a Chinese farmer was browsing the local slate quarry near Jingzhou City, located on the banks of the Yangtze River. A strange rock entered his view, and when he touched it, it split open—revealing information about humanity’s ancient past.
Inside the slab was a nearly complete, mouse-sized primate skeleton: each side of the rock’s two halves bore a distinct impression of the bony structure. With an age of 55 million years old it is the oldest primate skeleton yet discovered, dating from only 10 million years after the dinosaurs became extinct. Researchers believe that it is the earliest known member of a broad group of animals, which includes humans.

“What’s really important about the fossil is that it’s so complete,” says Marian Dagosto, cell and molecular biology, a member of the international team of paleontologists who studied the piece. “One of the most frustrating things about being a paleontologist is that you usually only find bits and pieces.”

The farmer donated the fossil to one of Dagosto’s longtime collaborators, Xijun Ni of the Institute of Vertebrate Paleontology and Paleanthropology at the Chinese Academy of Sciences in Beijing. Ni’s research team meticulously took 10 years to describe the primate and assess its importance. During that time, the researchers studied 1,186 morphological features, comparing them with 157 extinct and living mammals.

The first paper documenting their work was released in June 2013 in Nature. In addition to Dagosto and Ni, the article’s coauthors are K. Christopher Beard of the Carnegie Museum of Natural History in Pittsburgh; Dan Gebo of Northern Illinois University; Paul Tafforeau of the European Synchrotron Radiation Facility in France; and Jin Meng and John Flynn of the American Museum of Natural History in New York.

**Familiar Foot**

Small enough to fit into the palm of a hand, the long-tailed, wide-eyed creature subsisted on bugs and leapt along the canopies of tropical trees. It most closely resembles a tarsier, a small primate native to the Philippines. But the fossil also includes features more similar to anthropoids, the suborder of primates that includes apes, monkeys, and us.

![Familiar feet: The found primate’s heel bone and proportions of its metatarsals are similar to apes and humans. A: Dorsal view of the left foot, reversed. B: Plantar view of the left foot. C: Plantar view of the right foot, reversed. D: Dorsal view of the right foot. Arrows point at the scutiform distal phalanges of the big, second, third, and fifth toes.](image-url)
“We could say it looks like all other tarsier-like fossils,” Dagosto says. “But when the foot became clear, we realized it was not just your run-of-the-mill member of this group.” The primate’s heel provides a strong connection between humans and our possible ancestors. Its heel bone and the proportions of its metatarsals are very similar to those of other anthropoids.

An expert in primate limbs, Dagosto examined the shape of the leg and foot bones by way of 3-D renderings from data taken by high-beam X-rays at the European Synchrotron Radiation Facility. The X-ray images allowed researchers to peer inside the rock to see the hidden details, virtually extracting the delicate bones without touching them.

“The fossil represents a creature near the common ancestor for two major lineages of primates,” Dagosto says. “One of which is the tarsier and the other of which is monkeys, apes, and man.”

The research team named the specimen Archicebus achilles. Combining the Greek terms for “the beginning” (archi) and “long-tailed monkey (cebus), Archicebus roughly translates as “the first long-tailed monkey”; achilles refers to its heel.

Completing the Puzzle

Although now dry and rocky, the area where Archicebus achilles was found in China was once hot and wet, dotted by lakes and surrounded by trees. The fossil was preserved as a result of the lack of oxygen at the bottom of a long-disappeared lake. “The animal died and fell in,” Dagosto explains. “So it was undisturbed by
predators and covered by sediment. The biggest help was having it so complete. If we had just found its arms, then we wouldn’t have predicted the shape of its feet.”

Dagosto says that by looking at a joint, she can determine its function. For Archicebus achilles, the hip and knee joints have large ranges of motion, adapted for jumping. Its long legs acted like springs, increasing the length of the jump. It most likely spent its days leaping through trees, constantly on the move to hunt insects and keep from losing body heat.

The discovery of Archicebus achilles also supports the hypothesis that primates originated in Asia and then made the journey to Africa a few million years later. “Everything we find is a little piece of the puzzle,” Dagosto says. “We’re trying to determine the history, and we keep filling in gaps of the story.”

— Amanda Morris

All animal photos in the infographic are used from the Wikipedia Commons
Human photo by Jeanine Shimer

Marian Dagosto,
Feinberg School of Medicine
Research safety: then and now
In a 1940s photo from the Northwestern University Archives, chemistry professor L. Carroll King demonstrates the potential of chemical reactions. Wearing what looks like a pair of sunglasses to shield his eyes from ultraviolet radiation, he lacks the protection provided by the safety equipment we rely on today.

Today, blue is the new purple
Graduate students accompany Eberhard Zvergel, lecture demonstrator, chemistry, during another successful Halloween Show in Tech in 2012. Wearing flame-resistant lab coats (a specially treated 100 percent cotton), modern polycarbonate safety glasses, and protective gloves, today’s faculty, staff, and students can reduce their risk of harm far more than scientists in years past.

— Michael Blayney