

Research *at* Penn





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Penn's Research Enterprise

Research is part of Penn's core. The University's new and continued work, studies, and findings each year stretch near and far, proving significant impact for the global greater good.

We develop therapies to fight deadly diseases, examine the structure of dark matter halos, and investigate decades-old paleontological mysteries. We preserve endangered cultural histories, identify best practices to improve children's education, and study how human cells are influenced by the physical forces in the environment.

Whether it involves business, health, humanities, technology, or natural and social science, Penn researchers have their hands in it. And thanks in large part to federal funding, which is explored more in-depth in this edition, their biggest, most innovative dreams have the potential to come true.

Since Penn's inception, founder Benjamin Franklin hoped the University would conduct research that was more than just for research's sake. The goal has always been to help others.

We don't take that mission lightly. The annual *Research at Penn* magazine, now in its 16th year, gives a glimpse into what we've been up to. As you can see, we haven't been holding back.

To keep up with all the University's research news, visit Penn's research website: www.upenn.edu/researchdir.



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Transplanting Kidneys with Hepatitis C Saves Lives, Cures Disease

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ore than 97,000 people in the United States are currently awaiting kidney transplants—waits that can take five years or longer.

Results from a clinical trial could lead to about 1,000 more kidney transplants each year.

The research, led by David Goldberg, an assistant professor of medicine and epidemiology, and Peter Reese, an associate professor of medicine and epidemiology, both in the Perelman School of Medicine, shows that 10 patients' lives were transformed by kidney transplants from deceased donors infected with the Hepatitis C virus (HCV).

By establishing that it is possible to eradicate

HCV from patients who contract the virus from a transplant, researchers say this could open up access to more donor organs currently being discarded—and hopefully lessen the wait time for some patients.

“Our pilot data demonstrate the ability to cure the contracted virus following transplantation in this patient population,” says Goldberg. “If future studies are successful, this may be a viable option for patients who may otherwise never see a transplant.”

Reese says patients who were willing to participate in the trial received high-quality kidneys.

“Over time, David and I have come to believe that just because the donor has Hepatitis C, their kidney quality may not be impaired, especially if you can cure the virus,” says Reese,

who recently completed a term leading the Ethics Committee for the United Network for Organ Sharing.

To enroll participants, researchers reached out to patients who relied on time-consuming dialysis treatments and who had been waiting for new kidneys for no more than a year and a half.

Goldberg and Reese knew that, if unsuccessful, some or all of the patients would not only contract HCV but have the disease for the rest of their lives.

“The more we talked to patients, many of them accepted the unknown to get a chance of getting their freedom back,” Reese says.

The 10 patients in the first phase received their transplants, on average, 58 days after enrolling. Three days after surgery, patients were tested for HCV; all 10 tested positive. Patients



“IF FUTURE STUDIES ARE SUCCESSFUL, THIS MAY BE A VIABLE OPTION FOR PATIENTS WHO MAY OTHERWISE NEVER SEE A TRANSPLANT.”

were then treated with Zepatier, a recently approved, highly effective oral medication, and were cured of the virus. Merck supported the study and donated the drugs used in the trial.

After positive results, Goldberg and Reese were granted an extension to the trial, which will enable them to transplant and treat an additional 10 patients.

They are also carrying out a new clinical trial that will examine this same approach in patients who are awaiting heart transplants. In the future, they hope to look at liver and lung transplants as well.

“We realized that the amazing transformation of treatment options for Hepatitis C should also transform how we think about organs with Hepatitis C,” Goldberg says.

Diabetes Third-Leading Cause of Death

Diabetes accounts for 12 percent of U.S. deaths, third after heart disease and cancer, according to results published in *PLOS ONE* from Penn demographer Samuel Preston of the School of Arts and Sciences and Boston University’s Andrew Stokes. That’s a much higher percentage than previously thought.

Examining the health records of 300,000 people with and without diabetes from birth until death, the researchers learned that complications surrounding the disease typically prevent it from being listed as the primary cause of death. This, in turn, gives it less weight as a significant contributor to mortality patterns.

“Some major threats to U.S. mortality and life expectancy stand out, like drug and alcohol poisonings and suicide,” Preston says. “Diabetes doesn’t.”

Given this research, he says, it’s clear that it should in the future.

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A Turning Point in the Fight Against Cancer

In 2017, a personalized cellular therapy developed by the Perelman School of Medicine and Children's Hospital of Philadelphia won approval by the U.S. Food and Drug Administration (FDA). This treatment is for patients up to 25 years old with B-cell precursor acute lymphoblastic leukemia that is refractory or in second or later relapse.

Investigators Carl June, Stephan Grupp, David Porter, Noelle Frey, Bruce Levine, Michael Milone, and Shannon Maude, who together led research, development, and clinical trials of the new therapy in collaboration with Novartis, hailed the FDA's approval as a game changer for the treatment of younger patients battling the aggressive blood cancer, and a pivotal milestone in this new era of cellular therapies that treat cancer with a patient's own immune system.

MAKING SOLID TUMORS VULNERABLE TO IMMUNOTHERAPY

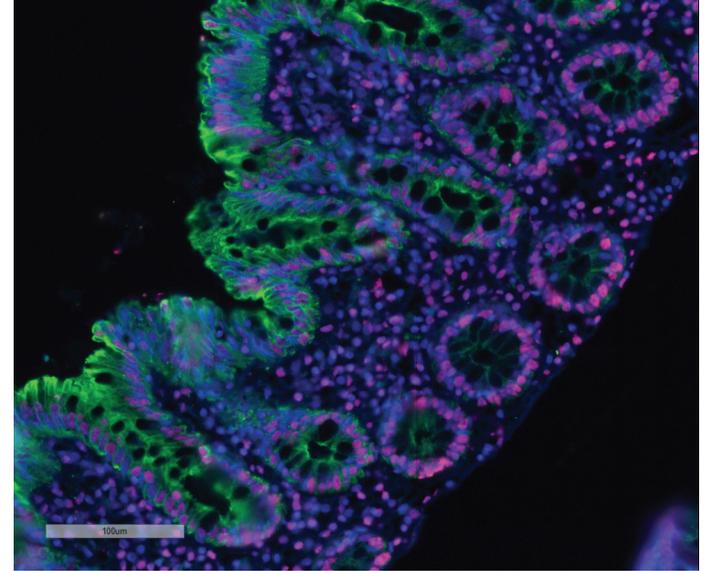
Immunotherapies have revolutionized cancer treatment, rooting out malignancies that have stubbornly survived other existing treatments. Yet solid tumor cancers often resist these approaches.

By untangling how tumors evade immune detection, research led by Serge Y. Fuchs, a professor of cell biology in the School of Veterinary Medicine, shows how immunotherapies may be modified to tackle solid tumors.

The focus of the National Institutes of Health-funded study was the protein type 1 interferon receptor (IFNAR₁), which is activated by interferon, a molecule known to fight cancers. When a tumor forms, its oxygen-deprived environment leads to a reduction in levels of the interferon receptor on T cells. This reduction precipitates the T cells' demise, creating an environment where cancer cells can survive and reproduce unchecked.

"This down-regulation of the receptor is required for the generation of immune-privileged niches in the tumor microenvironment," Fuchs says about the work, published in the journal *Cancer Cell*. "Accordingly, this loss of IFNAR₁ decreases the efficacy of immune therapies. If we can reverse that, then we'll probably improve the outcome of treatment."

Earlier research had found that immune-related genes decline in expression in the deep tumor microenvironment. In the current work, Fuchs and his team investigated whether



In a normal human colon, the IFNAR₁ receptor activity (represented by glowing pink) helps fight tumor cells. A loss of this activity leads to areas of a tumor where immune cells find it difficult to survive.

IFNAR₁ was involved in this dip in immunity, looking specifically at colorectal cancer, which does not respond well to immunotherapies. They noted that IFNAR₁ levels were drastically lower in cells from colorectal cancer patients' tumors. Lower levels were associated with poorer patient outcomes.

Working out the mechanism in mice, the team found that animals with a modified form of IFNAR₁ that resists degradation were less likely to develop tumors after receiving a transplant of tumor cells compared to genetically normal mice.

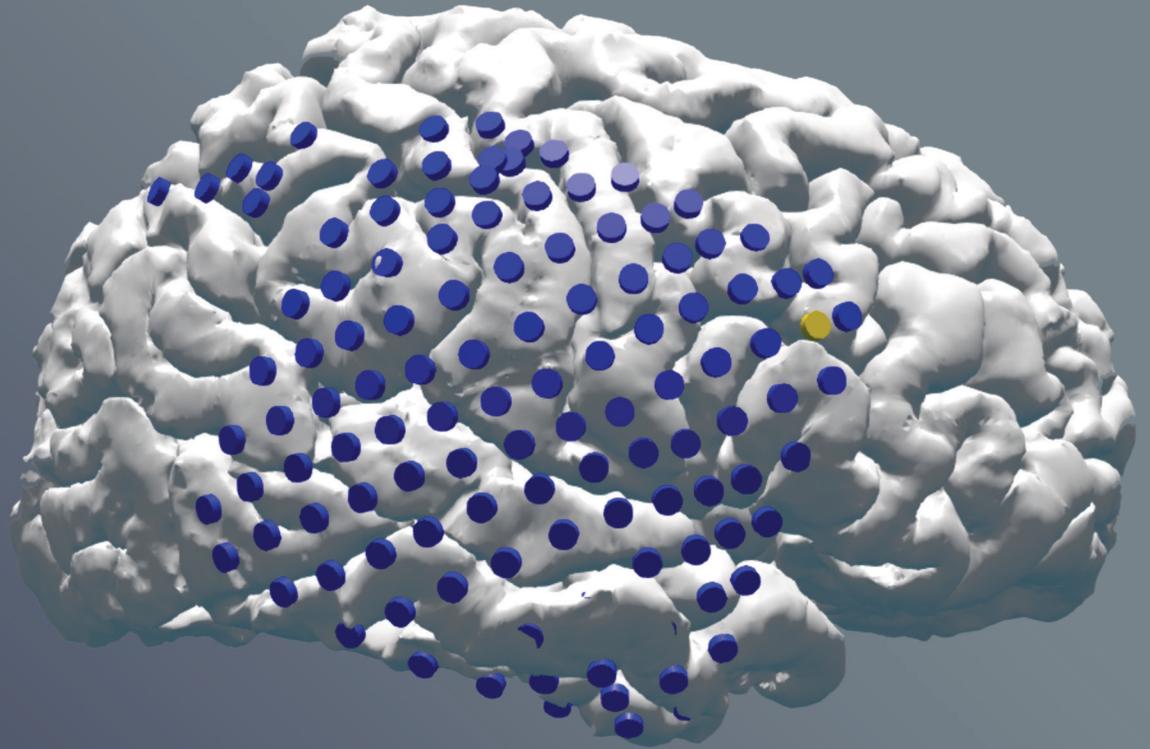
Normal mice were also found to have fewer "killer" T cells surviving inside the tumors, explaining why immunotherapies based on genetically engineered T cells may have low efficacy in solid tumor cancers: They simply can't survive long enough to have an effect against the cancer cells.

Fuchs and colleagues set about building a better immunotherapy. By stabilizing IFNAR₁ in the transferred T cells, they enabled more killer T cells to survive inside the tumors, where they had a strong anti-tumorigenic effect.

The team is now hoping to improve chimeric antigen receptor (CAR) T cell immunotherapies, which involve genetically modifying a patient's own immune cells by stabilizing IFNAR₁.

"Technically it's not very simple, but it should be feasible," Fuchs says. "And that would be very, very sweet."

Restoring Memory Function with Brain Stimulation



Blue dots indicate overall electrode placement; the yellow dot (top-right corner) indicates the electrode used to stimulate the subject's brain to increase memory performance.

A team of Penn neuroscientists has shown for the first time that electrical stimulation delivered when memory is predicted to fail can improve memory function in the human brain. That same stimulation generally becomes disruptive when electrical pulses arrive during periods of effective memory function.

The research team, which published its findings in *Current Biology*, included Michael Kahana, a professor of psychology in the School of Arts and Sciences and principal investigator of the Restoring Active Memory (RAM) program; Youssef Ezzyat, a senior data scientist in Kahana's lab; and Daniel Rizzuto, director of cognitive neuromodulation in the Computational Memory Lab.

This work is a crucial step toward the long-term goal of RAM, a four-year Department of Defense project aimed at developing next-generation technologies that improve memory function in people who suffer from memory loss. It illustrates an important link between appropriately timed deep-brain stimulation and its potential therapeutic benefits.

To get to this point, the Penn team first had to understand and decode signaling patterns that correspond to highs and lows of memory function.

"By applying machine-learning methods to electrical signals measured at widespread locations throughout the human brain, we are able to identify neural activity that indicates when a given patient will have lapses of memory encoding," Ezzyat says.

Using this model, Kahana's team examined how the effects of stimulation differ during poor versus effective memory function. The study involved neurosurgical patients receiving treatment for epilepsy at nine institutions. Participants were asked to study and recall lists of common words while receiving safe levels of brain stimulation.

During this process, the Penn team recorded electrical activity from electrodes implanted in the

Gaining insight into this process could improve the lives of many patients, particularly those with traumatic brain injury or neurological diseases.

patients' brains as part of routine clinical care. These recordings identified the biomarkers of successful memory function: activity patterns that occur when the brain effectively creates new memories.

"We found that when electrical stimulation arrives during periods of effective memory, memory worsens," Kahana says. "But when the electrical stimulation arrives at times of poor function, memory is significantly improved."

Gaining insight into this process could improve the lives of many patients, particularly those with traumatic brain injury or neurological diseases.

"Technology based on this type of stimulation could produce meaningful gains in memory performance," Rizzuto says.



A 'SNIFF TEST' FOR ALZHEIMER'S DISEASE

A

lzheimer's disease is a progressive, degenerative condition for which there is no cure. Current treatments do not provide much relief from symptoms like confusion and forgetfulness and cannot replace the lost brain tissue that is a hallmark of the disease.

Therefore, much of the current research focuses on early detection as the primary target for intervention.

"No existing drugs are going to fix your hippocampus and put your memories back," says David Roalf, an assistant professor in the Department of Psychiatry at the Perelman School of Medicine.

Memory tests are good at identifying patients with Alzheimer's but miss as many as a quarter of patients with an earlier stage of decline in brain function called mild cognitive impairment, or MCI. Some people with MCI may go on to develop Alzheimer's or another form of dementia, while others may not, and researchers are looking for new ways to identify those at risk. The nose, which has neurons that connect directly to memory's home in the hippocampus, is one such screening prospect.

"Alzheimer's is primarily a memory disorder, but other things also go awry," Roalf says. "Senses like sight, hearing, touch, and smell are dampened."

Roalf led research supported by the National Institutes of Health on a "sniff test" for Alzheimer's disease. In the study, adults with MCI, Alzheimer's, or no cognitive impairment were asked to identify familiar odors in conjunction with an established clinical memory assessment.

By having patients at the Penn Memory Center smell the clinical equivalent of scented markers, the researchers were able to pinpoint 92 percent of the adults with MCI, compared to the 77 percent identified with just a cognitive test. The combined test also improved their ability to identify patients with Alzheimer's.

The "sniff test" scents are meant to be easily recognizable to most people, and include familiar odors like orange, banana, garlic, and fish. The test is also quick and easy to administer, and Roalf hopes that it can be used to help identify individuals with cognitive impairment who slip through the current memory-based tests.

"It's easy to fool your memory," Roalf says, "but it's hard to fool your sense of smell."

Healing Wounds

When skin is injured, the body immediately gets to work repairing the break in its outermost barrier. The price of this speedy healing is a visible, collagen-filled scar lacking the hair follicles, fat cells, and sweat glands of normal skin.

Research supported by the National Institutes of Health and led by George Cotsarelis, chair of the Department of Dermatology and the Milton Bixler Hartzell Professor of Dermatology at the Perelman School of Medicine, seeks to shift the scarring process to one of regeneration.

Some amphibians and fish can regenerate tissue, but mammals generally don't have such capabilities.

"Humans have evolved to repair wounds as quickly as possible in order to prevent blood loss and infection," Cotsarelis says. "It's much faster to repair something than to regenerate it."

Previous work in the Cotsarelis lab had already identified factors that encouraged the growth of new hair follicles after an injury. By observing wound healing past the point of skin closure, former lab member Mayumi Ito, now at

Without Scars

DERMATOLOGY

HEALTH

New York University, noticed that new fat cells had appeared around the follicles.

In a study published in the journal *Science*, Cotsarelis and Maksim Plikus of the University of California, Irvine, helped to identify myofibroblasts, which pull the edges of wounds together, as the source of the transformed cells.

“Myofibroblasts have always been considered bad actors in scarring because they make all the excess collagen,” Cotsarelis says. “But they were actually the cells that were turning into fat.”

The research demonstrated the effect in both mice and human scar tissue cells.

“The first step was getting hair follicles to form in the wound,” Cotsarelis says. “After that, the fat regenerates in response to the signals from those follicles.” The researchers identified the key signal produced by the follicles as bone morphogenetic protein.

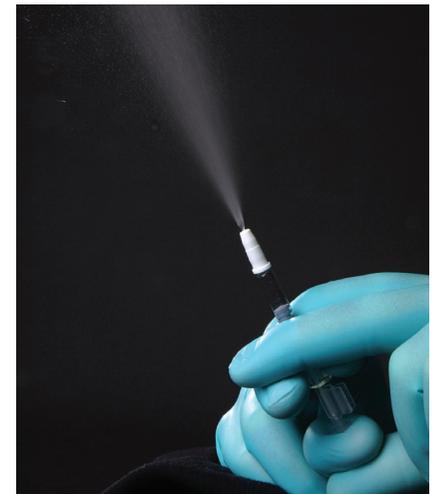
“Healing without scarring is highly desirable from a clinical standpoint, but right now it’s an unmet need,” Cotsarelis says. “Every type of wound results in a scar.”

In addition to the prospect for helping scarring, the findings have implications for improving the treatment of several conditions that cause loss of fat cells under the skin, including aging, certain medications, and congenital disorders.

Humans have evolved to repair wounds quickly to avoid blood loss and infection.

BRIEF

DENTAL MEDICINE



Pain-Free Dental Procedures

Relief for dental-phobes is here. Following a Phase 3 clinical trial led by Elliot Hersh, a professor in the Department of Oral and Maxillofacial Surgery/Pharmacology at Penn’s School of Dental Medicine, the U.S. Food and Drug Administration has approved a nasal spray anesthetic called Kovanaze for use before restorative procedures to the upper bicuspid, canine, or incisor teeth.

The Penn study, which was published in the *Journal of the American Dental Association*, found that the spray was safe and similarly effective to commonly used injectable numbing agents. Hersh is hopeful that this needle-free option will encourage more patients to address dental issues promptly, before minor problems turn into something serious.



Work Schedule Unpredictability Can Harm Health

For people who work in the service sector, schedules that frequently and unexpectedly change can lead to psychological stress and poor health, according to Kristen Harknett, an adjunct associate professor of sociology in the School of Arts and Sciences.

In collaboration with Daniel Schneider at the University of California, Berkeley, Harknett studied how much lead time eight of the largest U.S. retailers gave employees before they had to clock in and how often their daily and weekly schedules were adjusted. Workers with at least two weeks' advanced notice reported less stress, better overall health, and less trouble sleeping.

"There's a stark difference between people who have low wages but their schedules are stable," Harknett says, "and their counterparts with unstable and unpredictable work schedules."



THE CHALLENGES OF BREASTFEEDING AFTER MATERNITY LEAVE

Even with a sympathetic employer, breastfeeding mothers face an uphill battle when they return to work.

"Breastfeeding is hard work. It takes time, energy, commitment, and a supportive network both at home and in the workplace," says Diane Spatz, the Helen M. Shearer Term Professor of Nutrition at the School of Nursing.

In a two-part study, Spatz, who is also director of the lactation program at the Children's Hospital of Philadelphia (CHOP), worked with Elizabeth Froh, the clinical supervisor of CHOP's lactation team and Human Milk Management Center, to measure both the support and barriers encountered by breastfeeding mothers.

They published their initial quantitative findings in the journal *Breastfeeding Medicine* in 2014. In a second, qualitative arm that appeared in 2016 in the *Journal of Human Lactation*, they asked open-ended questions to document and analyze the perspectives of mothers returning to work at CHOP after the birth of a child.

"At CHOP, we have close to 50 lactation rooms, all equipped with a high-quality, hospital-grade electric pump," Spatz says. "CHOP's breastfeeding policy is actually much stronger than the national law."

Still, some mothers had difficulty taking multiple breaks to express milk during the workday. Some found that though their bosses supported their desire to breastfeed, their workload was not so accommodating.

"That is something women report universally once they go back to work," Spatz says. "Even when you have lots of resources and a strong policy, it still comes down to time."

Women also face inconsiderate comments from co-workers that can discourage a mom attempting to make pumping a part of her schedule.

"If you were back to work and breastfeeding, how many negative comments would it take for you to question what you're doing?" Spatz says. "Sometimes it only takes one."

Spatz stresses that although efforts to encourage breastfeeding have made huge strides, new mothers still need more support as they try to provide the best for their babies.

"The emphasis on breastfeeding is really in its infancy compared to other health promotion campaigns like smoking cessation," Spatz says. "We need to create a culture where it's valued to breastfeed."

Protecting the Brain from HIV Treatment

When it comes to treating HIV/AIDS, antiretroviral drugs such as protease inhibitors can be a double-edged sword.

“Protease inhibitors are very effective antiviral therapies, but they do have inherent toxicities,” says Kelly Jordan-Sciutto, chair and professor in the School of Dental Medicine’s Department of Pathology.

These drugs, while credited with cutting in half deaths from HIV/AIDS, have been implicated in contributing to HIV-associated neurocognitive disorders (HAND). Forgetfulness, confusion, and behavior and motor changes are among the symptoms.

In recent research, including a publication in the *American Journal of Pathology*, Jordan-Sciutto and colleagues have found key pathways through which the therapies seem to

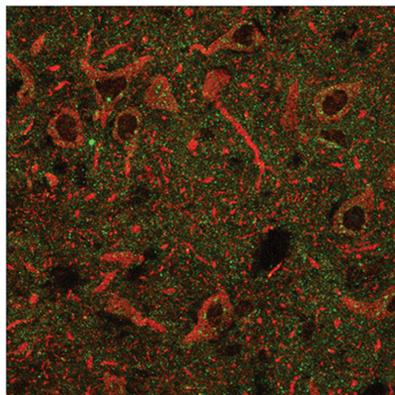
protein response could be generating damaging BACE1 activity in HIV patients as well.

The research team confirmed that the protease inhibitors ritonavir and saquinavir—both still widely used, especially in Africa—indeed triggered an increase in both amyloid precursor protein and in BACE1. Then, when they administered the drugs to cells in culture, they discovered increases in signs of the unfolded protein response, as well as jumps in BACE1 expression and amyloid precursor protein processing, representing neuronal damage. A BACE1 inhibitor applied to the cells prevented the drug-induced damage.

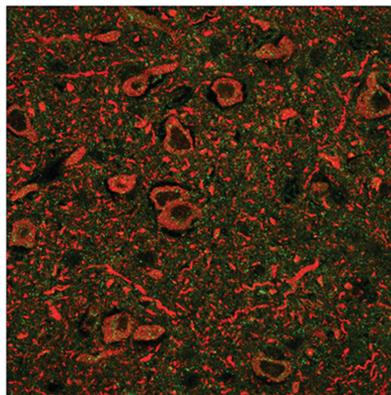
More recent work, led by Caglay Akay-Espinoza, a research assistant professor who works with Jordan-Sciutto,

In macaques with SIV, an HIV analog, Penn researchers found that antiretroviral therapy elevated levels of amyloid precursor protein (in green), a sign of neuronal damage.

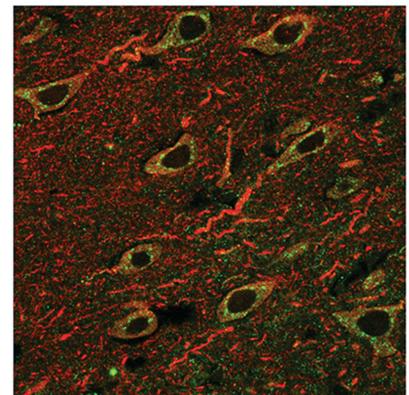
Uninfected



SIV⁺/placebo



SIV⁺/ART



harm the brain—pathways that could eventually be targeted by drugs to counter some of the cognitive impairments experienced by patients undergoing treatment.

Earlier studies by the Penn team generated evidence that HIV patients taking protease inhibitors had overactive stress-response pathways, including one known as the unfolded-protein response. They also knew that the unfolded-protein response could activate the enzyme BACE1. This latter finding intrigued the researchers, for BACE1 snips amyloid precursor protein to produce beta amyloid—the same molecule that clogs up the brains of Alzheimer’s patients. Perhaps, they thought, the unfolded-

confirmed that certain newer generations of HIV drugs, both protease inhibitors and another class called integrase strand transfer inhibitors, can also lead to neuron damage.

Jordan-Sciutto, who is also associate dean for graduate education and director of biomedical graduate studies in the Perelman School of Medicine, says the findings are not a reason to abandon effective HIV/AIDS therapies but do suggest that a drug that blocks BACE1 activity might put a dent in neuron damage.

“Our findings may cause us to rethink how we’re using these drugs and even consider developing an adjunctive therapy to reduce some of these negative effects,” she says.

Dark Matter Halos in Galaxies Far,

In the 1970s, scientists noticed something strange about the motion of galaxies.

All the matter at the edges of spiral galaxies was rotating just as fast as material in the inner parts of the galaxies. But according to the laws of gravity, objects on the outskirts should be moving more slowly.

The explanation: A form of matter called dark matter that does not directly interact with light.

Many scientists now believe that more than 80 percent of the matter of the universe is locked away in mysterious, as yet undetected, particles of dark matter, which affect everything from how objects move within a galaxy to how galaxies and galaxy clusters clump together in the first place.

This dark matter extends far beyond the reaches of the farthest stars in the galaxy, forming what scientists call a dark matter halo. While stars within the galaxy all rotate in a neat, organized disk, these dark matter particles are like a swarm of bees, moving chaotically in random directions, which keeps them puffed up to balance the inward pull of gravity.

Bhuvnesh Jain, the Walter H. and Leonore C. Annenberg Professor in the Natural Sciences in the School of Arts and Sciences, and postdoctoral student Eric Baxter are conducting research that could give new insights into the structure of these halos. The researchers wanted to investigate whether these dark matter halos have edges or boundaries. That is, does the dark matter extend smoothly from the cluster to the ambient universe?



Far Away

Using a galaxy survey called the Sloan Digital Sky Survey, Baxter and Jain looked at the distribution of galaxies around clusters. They formed a team of experts from the University of Chicago and other institutions around the world to examine thousands of galaxy clusters, the largest gravitationally bound objects in the universe. Employing statistical tools to map several million galaxies around them, they found a sharp drop at the edge of the cluster.

The research was published in the *Astrophysical Journal*.

In addition to seeing this edge in galaxy distribution, the researchers also saw evidence of it in the form of galaxy colors.

When a galaxy is full of gas and forming many big, hot stars, the heat causes it to appear blue in images. Smaller, older stars appear red.

Scientists expect that galaxies that have spent more time orbiting through a cluster will appear red due to the light from old stars (gas needed to form new stars was stripped by the cluster), while galaxies that are just starting to fall in will appear blue.

The researchers noticed a sudden shift in the colors of galaxies right at the boundary, providing them with more evidence that dark matter halos have edges.

The researchers hope that their work will contribute to a better understanding of the mysterious substance that makes up about 80 percent of matter in the universe. If they can mark the edge of a dark matter halo, it would allow them to test ideas like Einstein's theory of gravity and the nature of dark matter.

HOW SONGBIRDS TEACH THEMSELVES SONGS

NATURAL SCIENCE / BIOLOGY



Music can be a powerful form of expression. It's especially important for songbirds, such as zebra finches, which learn the songs of their fathers in order to court mates.

Until recently, scientists typically thought of the bird's vocal development in terms of how one circuit in the brain learns a song. But a new study by Penn researchers investigated how zebra finches accomplish this feat from a different perspective. Instead of looking at how the bird's whole brain learns a song, they studied how one part of its brain, which they dubbed the "tutor," teaches another part of its brain, the "student."

The research was led by Vijay Balasubramanian, a physics professor in the School of Arts and Sciences, and Tiberiu Teşileanu, a visiting scholar whose main appointment is at the City University of New York Graduate Center. They found that in order to teach effectively, the tutor must adapt its teaching style to how the student learns best. Their results were published in *eLife*.

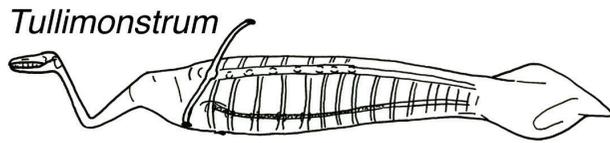
Zebra finches' song-learning process is similar to a musician learning a piece on the violin: After practicing the song over and over again until it sounds right, playing it becomes second nature.

In the case of zebra finches, the bird hears the song, remembers it, sings it back, and continues to adjust it over a period of about a month until it sounds right. As the bird sings, it learns to control its syrinx—the animal's vocal organ—and its respiratory muscles.

Students playing the violin might have many different learning styles. Some people are auditory learners, while others learn visually. Depending on the style of learning, different kinds of teaching may be more or less effective. The researchers found that the same is true in the brains of songbirds: Based on the synaptic plasticity rules, which are the learning rules neurons use, different types of teaching rules in the brain will be more effective.

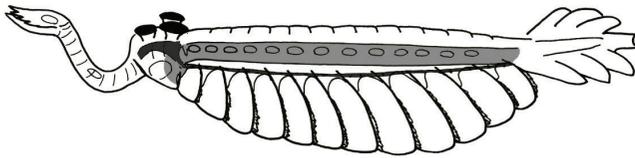
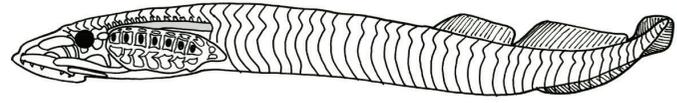
The researchers hope to think about this idea of matched learning and teaching in mammalian brains and cortical networks, which allow learning of motor function.

Learning, Balasubramanian says, doesn't just involve the student. It also involves the teacher. He says it's important to understand the roles of both areas of the brain.

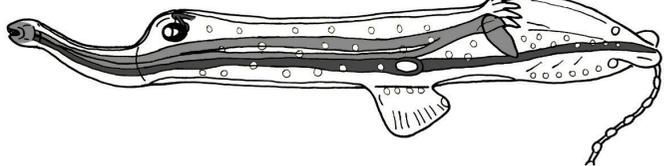


Tullimonstrum

Vertebrate (Lamprey)



Mollusc (Heteropod Gastropod)



UNLOCKING THE MYSTERY OF THE 'TULLY MONSTER'

In 2016, two scientific groups made headlines when they declared a decades-old paleontological mystery solved. They claimed that the “Tully monster,” an ancient animal that had long defied classification, was in fact a vertebrate. Specifically, they believed it was a type of jawless fish called a lamprey.

The problem with this resolution? According to a team led by Lauren Sallan, the Martin Meyerson Assistant Professor in Interdisciplinary Studies in the Department of Earth and Environmental Science in the School of Arts and Sciences, it’s plain wrong.

“This animal doesn’t fit easy classification because it’s so weird,” says Sallan, who was named a 2017 TED Fellow. “It has these eyes that are on stalks, and it has this pincer at the end of a long proboscis, and there’s even disagreement about which way is up.”

Writing in the journal *Palaeontology*, Sallan and colleagues argue that the two scientific papers that seemingly settled the Tully monster debate are flawed. The mystery of the Tully monster, known to scientists as *Tullimonstrum gregarium*, remains.

“Tully is anything but a fish,” Sallan says.

Tully monsters, which lived 300 million years ago, are torpedo shaped and around a foot long. Previously, they were believed

to be a worm, a mollusk, or even a lobster-like arthropod.

One of the earlier studies claimed to have determined that a light band running down the midline of some of the creatures was not a gut tube, as scientists once believed, but instead a primitive backbone. The other study’s authors said structures they detected in scanning electron microscope images of Tully monsters’ eyes pointed to them being vertebrates.

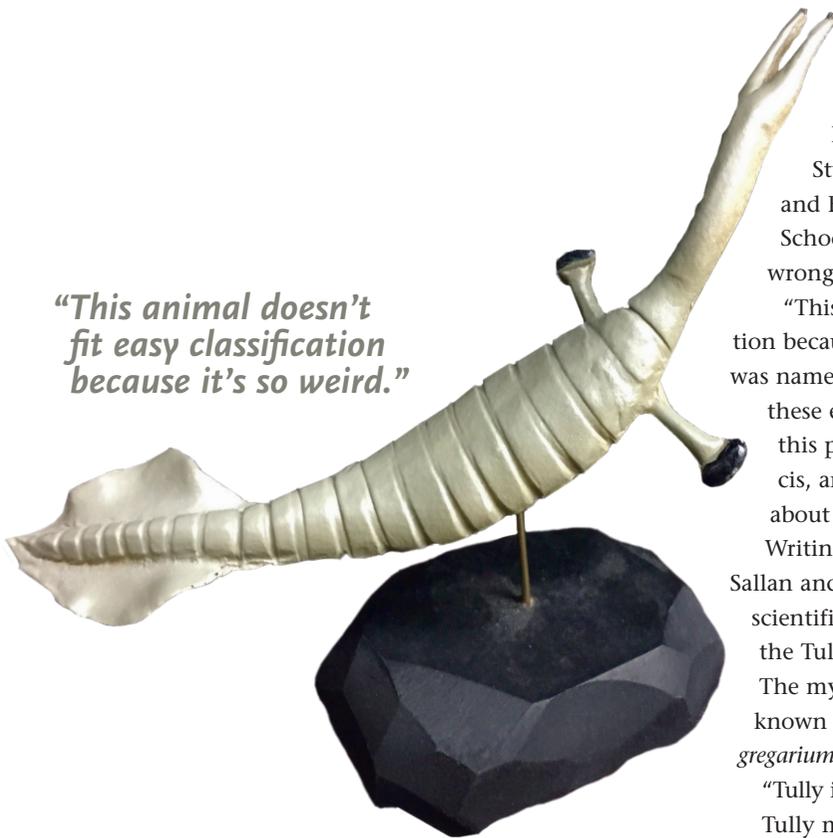
But Sallan and colleagues noted several incongruities in the evidence, including the fact that internal structures wouldn’t have been preserved in the marine deposits at Mazon Creek in central Illinois due to high acidity in the area.

In addition, she says that many types of early marine animals evolved similar physical structures in similar environments, complicating efforts to nail down an identification. The eye structure of Tully monsters, for example, is shared by distant relatives of fishes, but also mollusks and worms.

Sallan says that not only do new analyses claim to find things that are unlikely to be preserved in the Mazon Creek’s conditions, they also fail to find other structures universal to vertebrates—such as sand-like grains in the inner ear that help animals balance—that she has found in other vertebrate species in the same deposits.

“If you’re going to make extraordinary claims,” Sallan says, “you need extraordinary evidence.”

“This animal doesn’t fit easy classification because it’s so weird.”



'Ageing' Phenomenon Causes Powerful Earthquakes

NATURAL SCIENCE / GEOLOGY

Scientists have gotten better at predicting where earthquakes will occur, but they are still unsure about when earthquakes will strike and how devastating they will be.

In the search for clues, scientists at Penn are studying a phenomenon called "ageing."

In ageing, the longer materials are in contact with each other, the more force is required to move them. This resistance is called static friction. The longer an object, such as a fault, is sitting still, the more static friction builds up and the stronger the fault gets. As the fault gets stronger, stress can increase to large levels until a colossal amount of energy is released in the form of a powerful earthquake.

This Penn-based project seeks to understand the friction of rocks from a physical point of view at the nanoscale.

In their most recent paper, published in *Physical Review Letters*, the researchers, led by Robert Carpick, the John Henry Towne Professor and chair of the Department of Mechanical Engineering and Applied Mechanics

in the School of Engineering and Applied Science, and Kaiwen Tian, a Ph.D. student in the Department of Physics and Astronomy in the School of Arts and Sciences, used nanoscale experiments to verify a new fundamental theory to describe ageing and explain what happens when the compressive load forcing the surfaces together increases. The work involved collaboration with geoscientist David Goldsby of Penn's Earth and Environmental Science Department.

In addition to providing a better understanding of earthquakes, this work could lead to more efficient nano-devices.

Due to the fact that many micro- and nano-devices are made from silicon, understanding friction is key to getting these devices to function more smoothly.

But, most importantly, the researchers hope that somewhere down the line, a better understanding of ageing will enable them to predict when earthquakes will occur.

"Earthquake locations can be predicted fairly well," Carpick says, "but when an earthquake is going to happen is very difficult to predict, and this is largely because there's a lack of physical understanding of the frictional mechanisms behind the earthquakes. We have a long way to go to connect this work to earthquakes. However, this work gives us more fundamental insights into the mechanism behind this ageing. In the long term, we think these kinds of insights could help us predict earthquakes and other frictional phenomena better."

In ageing, the longer materials are in contact with each other, the more force is required to move them.



BIOLOGY

NATURAL SCIENCE

How Hatchetfish Use Light as Camouflage in the Deep Sea

According to Alison Sweeney, an assistant professor of physics in the School of Arts and Sciences, hatchetfish, so named because the shape of their bodies resembles the blade of a hatchet, are one of the "classic-example weirdo fish denizens of the midwater."

Hatchetfish have a line of photophores on their belly that produce light, or bioluminescence. This is useful when the fish are swimming in waters shallow enough to be dominated by sunlight. By producing their own light with the same intensity as the faint sunlight coming from above, the hatchetfish make themselves invisible to predators.

But this counter-illumination technique doesn't work in the deep sea, where sunlight is absent. In this region, other predatory sea creatures have evolved to create light with their own bodies, which they can use as searchlights to hunt for prey.

Until recently, scientists believed that hatchetfish were able to hide in the void because their reflective scales allowed them to behave like a mirror: Light traveling toward the fish would bounce

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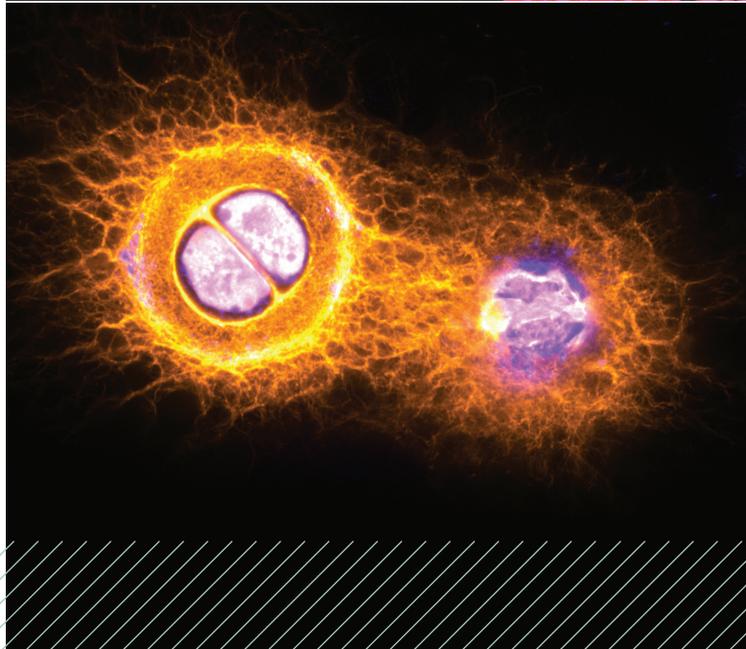
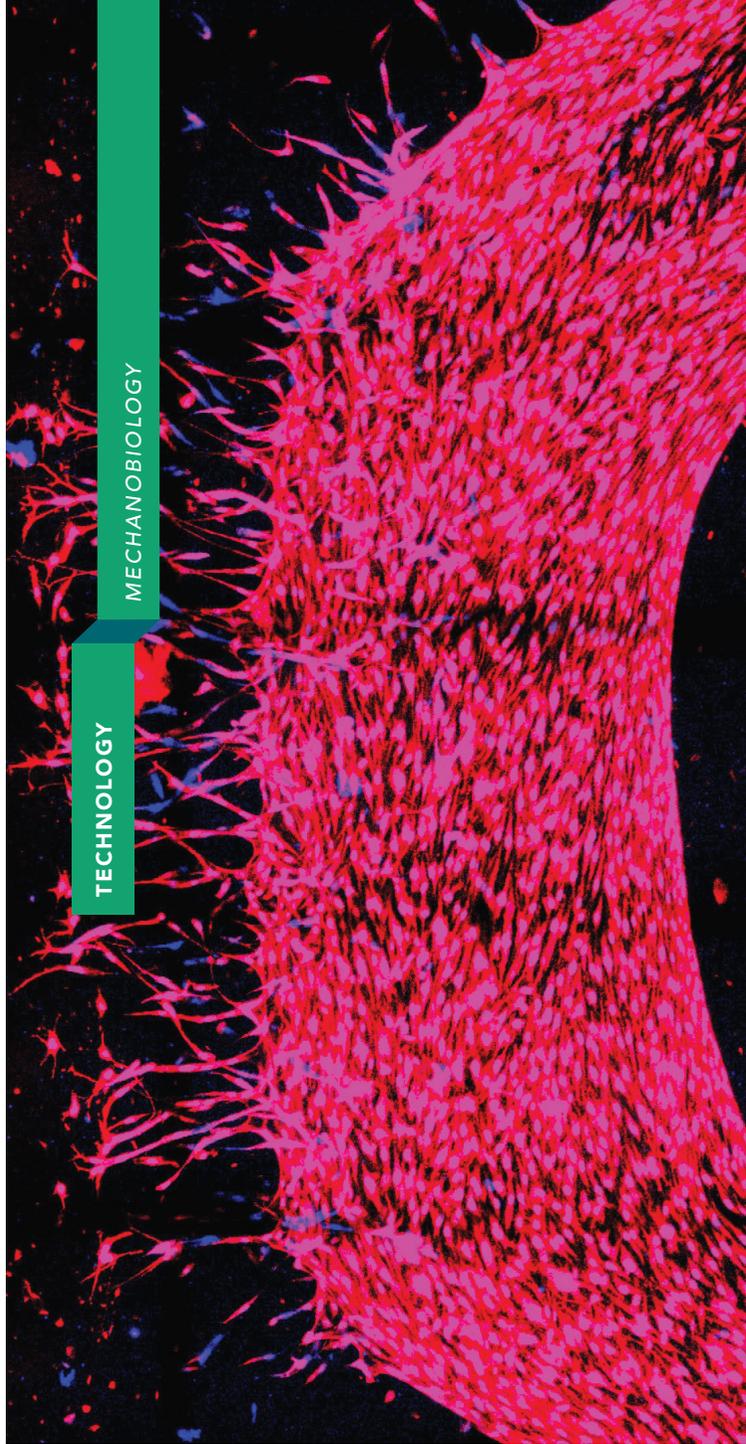
National Science Foundation Awards Penn \$24 Million to Establish Mechanobiology Center

The National Science Foundation (NSF) has awarded Penn a \$24 million, five-year grant to establish a Science and Technology Center focused on engineering mechanobiology, or the way cells exert and are influenced by the physical forces in their environment. This new NSF Center is a consortium and includes Washington University in St. Louis, Boston University, New Jersey Institute of Technology, Bryn Mawr College, and Alabama State University.

At Penn, the Center for Engineering Mechanobiology draws from faculty in the Perelman School of Medicine and the School of Engineering and Applied Science. Mechanical forces play a role in a wide variety of biological phenomena in plants and animals, so insights generated by the Center could provide a deeper understanding of embryonic development and stem cell differentiation, cancer metastasis, the dynamic factors that influence gene expression, and many other clinically and agriculturally relevant topics.

These insights will also inform innovations like organs-on-chips, which provide ideal testing platforms for human disease, and “cyborg” leaf devices, which can monitor plants’ natural mechanisms for responding to moisture and other environmental factors, and report those conditions to farmers.

“We are at a crucial juncture in the biological sciences,” says Center member Yale E. Goldman, a professor of physiology and biochemistry and molecular biophysics at Penn Medicine and mechanical engineering and applied mechanics at Penn Engineering. “We’re now just starting to understand how the force-sensing and mechanical outputs of cells pervade development, maintenance of health, and pathology of plants and animals—but we’re still doing this kind of research in isolated groups with limited interactions and separate goals.”



Mechanobiology uses engineering and biology to understand the way cells exert and are influenced by physical forces in their environment.



The Center will be led by Vivek Shenoy, a professor with appointments in Penn Engineering's departments of Materials Science and Engineering, Mechanical Engineering and Applied Mechanics, and Bioengineering; Richard Assoian, a professor of systems pharmacology and translational therapeutics at Penn Medicine; and Guy Genin, a professor of mechanical engineering at Washington University.

Other members of the Center's leadership include Penn Medicine's Rebecca Wells, a professor of medicine; Robert L. Mauck, the Mary Black Ralston Professor for Education and Research in Orthopaedic Surgery; and E. Michael Ostap, a professor of physiology and director of the Pennsylvania Muscle Institute.

By bringing together primary experts in plant and animal mechanobiology into an integrated framework of research and training, the Center will catalyze a new vision for biological, biomedical, and agricultural science, Shenoy says.

The Center will also have faculty members dedicated to translating findings from basic research into applications. This knowledge transfer arm will be led by Mauck and Dan Huh, the Wilf Family Term Assistant Professor of Bioengineering at Penn Engineering.

Research will be conducted in three groups, each dedicated to a different scale at which mechanobiological forces are at play: individual cells' molecular components and microenvironment, how cells use mechanical cues to signal to one another, and how these interactions come together to form larger assemblies and structures, which could inspire new biomaterials.

HELPING TO BOOST YIELDS ON SMALL FARMS IN CHINA

TECHNOLOGY / AGRICULTURE

Despite tremendous effort and good intentions, many international agricultural development efforts fail when the implementing agency leaves and the local farmers go back to their old practices. That's why a new type of intervention, involving Zhengxia Dou of the School of Veterinary Medicine and a team from China Agricultural University (CAU), tried a different tack: staying put.

Beginning in 2009, researchers from CAU embedded in small villages in China's Quzhou County, working directly with farmers to provide education and training and to help implement science-based agricultural practices. The framework, known as the Science and Technology Backyard (STB), helped substantially boost yields in the region, improving farmers' bottom lines and making more efficient use of natural resources.

"What makes the STB model unique is the zero distance: the STB staff living among the farmers in the village," says Dou, a professor of agricultural systems at Penn Vet. "That way they built trusting and intimate relationships with farmers. Such trust goes a long way. It motivates the participants, it accelerates knowledge transfer, and it sustains the results."

Farmers in Quzhou County, who grow primarily maize and wheat, suffered

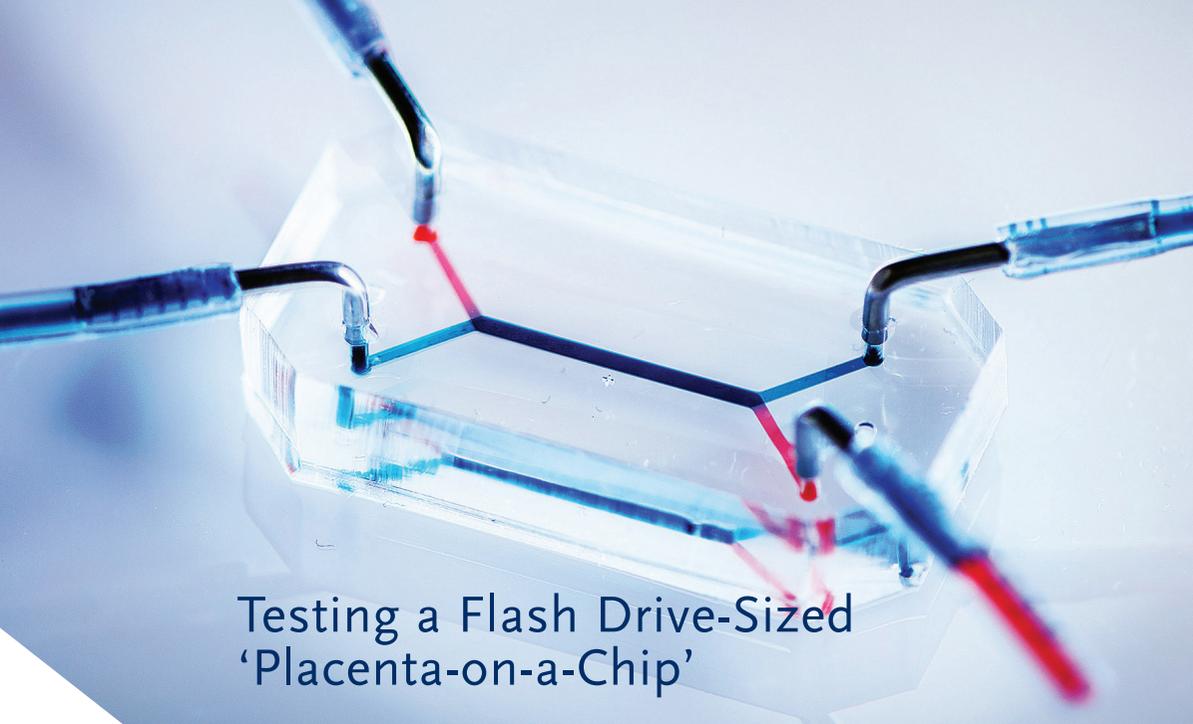
relatively low yields at the turn of the 21st century, averaging roughly 63 percent of what researchers could attain on equivalent plots. To help address and narrow this so-called "yield gap," the STB researchers living in Quzhou villages surveyed 150 farmers and conducted experiments on the ground to identify several factors that could be improved, compiling a set of 10 recommended practices. After discussing these practices with leading farmers, they received feedback on which of these could



be implemented and which were not practical.

As the researchers reported in the journal *Nature*, under the STB platform, the five-year average yield among leading farmers increased from 67.9 percent of the attainable level to 97 percent; the countywide figure increased from 62.8 percent to 79.6 percent.

Dou and colleagues have been expanding the STB to other areas of China, reaching upward of 20 million small farmers. Together with another project to improve the health and efficiency of China's dairy industry, supported by one of Penn's inaugural China Research and Engagement Fund grants, Dou hopes to strengthen food security in China, providing a blueprint that can be followed elsewhere around the world.



Testing a Flash Drive-Sized 'Placenta-on-a-Chip'

The device contains two layers of human cells that model the interface between mother and fetus.

TECHNOLOGY / BIOENGINEERING



The placenta acts as a selective gate-keeper that protects and nourishes a growing fetus by allowing some components of a mother's blood to pass through while blocking others.

This is not a simple task, and little is known about how the placenta accomplishes this complex function.

"The placenta is arguably the least understood organ in the human body," says Dan Huh, the Wilf Family Term Assistant Professor of Bioengineering in the School of Engineering and Applied Science.

Much remains to be learned about how transport between mother and fetus works at the tissue, cellular, and molecular levels, Huh says. Though these types of studies are currently possible using real placentas obtained after delivery, the complexity of working with the whole organ and its limited availability pose major practical challenges. To overcome this obstacle, Huh and Samuel Parry, chief of Maternal Fetal Medicine and the Franklin Payne Professor of Obstetrics and Gynecology in the Perelman School of Medicine, worked with collaborators at the University of Colorado to create a new model: a placenta-on-a-chip.

The research was supported by Penn's March of Dimes Prematurity Research Center and the National Institutes of Health.

In a study published in the journal *Lab on a Chip*, the researchers describe the flash drive-sized device. Two layers of cells separated by a porous barrier mimic a tissue barrier between the maternal and fetal blood in the placenta. Microfluidic channels allow the researchers to introduce various types of materials to the "placenta" and study how certain molecules interact with the barrier.

Importantly, the team also demonstrated that this chip not only replicates the salient structure of the placental barrier, but also retains its key physiological transport function. For example, the microengineered placenta allows glucose to pass through much like a real placenta would.

In a subsequent study published in the journal *Advanced Healthcare Materials*, the researchers tested the chip using glyburide, a drug commonly used to treat gestational diabetes. It has been shown that cells on the maternal side of the placental barrier express active drug transporters called GLUTs responsible for keeping glyburide from reaching the fetus. Huh's group was able to replicate this protective effect in the placenta-on-a-chip.

"This study really demonstrates the potential of our model as a screening platform to assess the risk of fetal exposure to new and existing drugs," Huh says.

Developing a Low-Cost

TECHNOLOGY / MECHANICAL ENGINEERING

At the height of the Zika epidemic, two professors at the School of Engineering and Applied Science developed a cheap, portable, point-of-care diagnostic system that could detect the virus in less than an hour.

The World Health Organization has since declared the Zika emergency over, but the need for accurate point-of-care testing, which allows for evidence-based disease management in poor resource settings and faster results, has not waned. Zika and other diseases like dengue, chikungunya, and malaria continue to infect people in places without easy access to a lab.

Haim Bau, a professor in the Department of Mechanical Engineering and Applied Mechanics, worked with research associate professor Changchun Liu and received funding from the National Institutes of Health to develop the test. The research was published in the journal *Analytical Chemistry*. The device they created heats a microfluidic chip where an assay detects the presence of the virus.

The system is now being tested in Panama to gauge its effectiveness against polymerase chain reaction (PCR), the current standard. Both the new and standard tests look for the genetic material of the virus itself, making them more precise than those that measure the body's response to infection. However, PCR requires sophisticated equipment and three precise temperature manipulations, making it unsuitable for use in under-resourced areas of the world.

Bau and Liu's assay uses a different procedure called loop-mediated isother-

Test for the Zika Virus

mal amplification (LAMP), which they power using the same heating element found in meals carried by backpackers. If the system gets too hot, a waxy substance melts to absorb excess heat. When LAMP detects the distinct nucleic acids of the target virus, a fluorescent marker lights up or a dye changes color. Depending on the viral potency of the sample, the entire process takes 40 minutes or less.



The test is housed in a thermos with a custom 3-D printed lid designed to hold a smartphone, which both activates and records the signal from the fluorescent dye. When colorimetric dye is used, the smartphone is not needed. The entire apparatus is inexpensive, and by switching the assays or tweaking the test to detect multiple diseases at once, it could be used to identify other pathogens.

“This is essentially a diagnostic device that can be used for any applications that require detection of nucleic acids,” Bau says. “It could cover the entire spectrum of infectious diseases.”



WOMEN WITH IN-HOME TECHNOLOGY FIND WIFE BEATING UNACCEPTABLE

How does technology affect attitudes about gender roles and violence against women?

Women with technology in their homes are more likely to reject wife beating as acceptable, according to findings published in the *American Journal of Public Health* by Susan B. Sorenson, director of the Evelyn Jacobs Ortner Center on Family Violence and a professor of social policy in the School of Social Policy & Practice, and Lauren Cardoso, an Ortner Center fellow and Ph.D. candidate in social welfare.

“We imagined that access to information could have a positive impact on norms about violence against women,” Cardoso says. “That’s where we started.”

The researchers turned to United Nations Children’s Fund data in 20 low- and middle-income countries. They looked at how more than 130,000 15- to 49-year-old women considered two topics. First, are there information and communication technologies in the home? And, second, is ownership of these technologies related to justifications for wife beating (i.e., is a husband justified in hitting his wife if she goes out without telling him, neglects the children, argues with him, refuses to have sex, or burns the food?). They also controlled for the wealth of each household as well as the wealth and development of each country.

Analysis showed that women in homes with a radio, computer, cell phone, or landline were less likely to accept justifications for wife beating. In addition, the more technologies present, the greater the chance for rejecting such justifications.

The aim of this work, the first of its kind, was to move beyond direct interventions—solving a problem like intimate partner violence by educating school children about healthy, equitable relationships, for instance—to those more indirect or incidental. Sorenson says technology was an obvious fit.

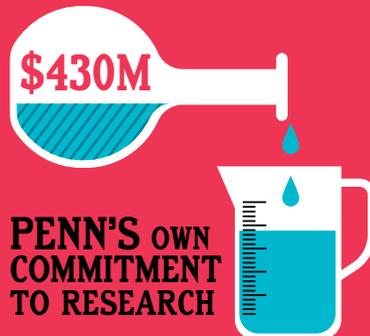
“The private sector is putting a lot of effort into making sure information and communication technologies are available globally,” she says. “But companies, policymakers who set regulations, and researchers haven’t been paying attention to potential unintended outcomes that are secondary to business plans.”

Sorenson and Cardoso see some obvious next steps, namely, to better understand men’s perspectives as well as to assess whether women whose homes contain such technologies use them. For now, the researchers say their results reinforce the need to continue prioritizing women’s access to technology.

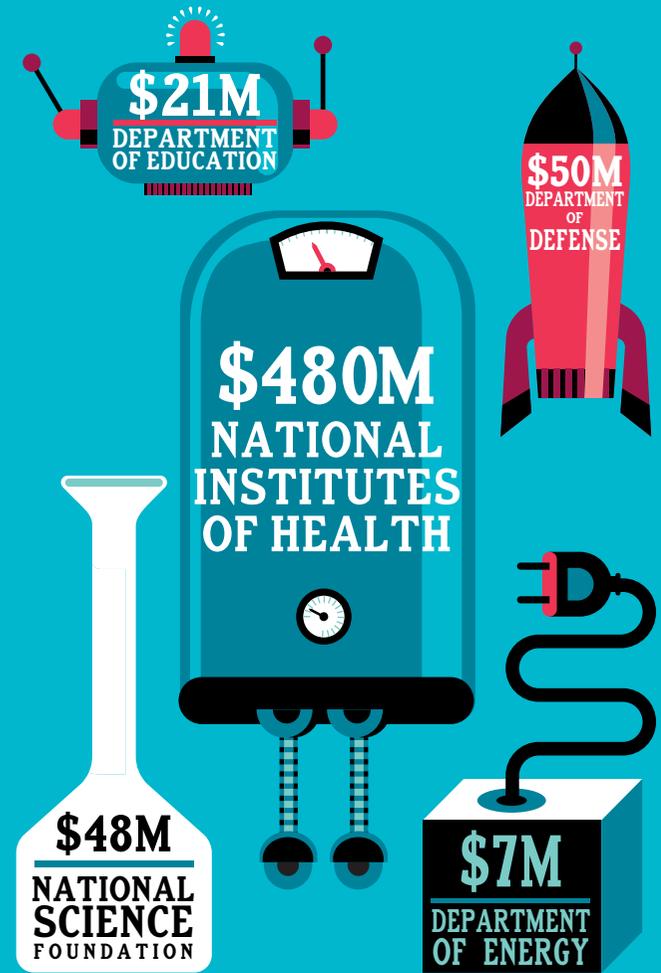


IN **2016**
PENN
 WAS
FOURTH IN
 NATIONAL
 INSTITUTES OF
 HEALTH FUNDING

#6
 IN FEDERAL OBLIGATIONS
 AMONG ACADEMIC INSTITUTIONS



IN 2016 PENN RECEIVED:



Federal Funding's Far Reach at Penn

Penn researchers work every day to discover cures for diseases, design robots to advance our lives, and turn ideas from basic science into applications that will impact the greater good.

They're on the ground preserving endangered history, setting standards that improve education for children, and fighting for what's right one injustice at a time.

You name it, if it's cutting edge, the University's researchers have their hands in it. "From the very beginning, dating back to our founder Benjamin Franklin, it's been at our core to challenge the frontiers of knowledge," says Penn's Vice Provost for Research Dawn Bonnell. "And we've always been about having inventions that actually help people."

Today's Penn is a booming research enterprise known for revolutionary contributions ranging from ENIAC, the world's first all-electronic computer that was created at the University in the 1940s, to a personalized cellular therapy for advanced leukemia that was historically approved by the FDA in 2017. But without the help of federal funding, these developments might not have been possible.

In 2016 alone, Penn—with an impressive \$1 billion research budget—earned more than \$730 million in federal grants, with more than \$480 million from the National Institutes of Health (NIH), the world's greatest source of funding for medical research. Other federal agencies that support University research include the National Science Foundation and the departments of Defense, Education, and Energy.

This support, leveraging Penn's own \$430 million commitment and funding from industry and foundations, often goes toward paying for salaries of investigators, trainees, and workers in labs; costly equipment and supplies that go into experiments; and the infrastructure and facilities that keep everything top-notch.

"The partnership between the federal government and research-intensive universities, which formally began in the years following World War II and leading up to Sputnik, was really what created the vibrant scientific community and ecosystem of discovery that's at the heart of everything we do," says Steven Fluharty, dean of the School of Arts and Sciences. "Absent of that, it would have been very difficult for universities themselves to develop such large research programs."

BREAKDOWN OF RESEARCH AWARDS

FROM ALL SPONSORS

2016

FEDERAL
70%

COMMERCIAL INDUSTRY
16%

NONPROFIT/
FOUNDATIONS
12%

NONFEDERAL GOVERNMENT
2%

PERELMAN SCHOOL OF MEDICINE + \$741M

SCHOOL OF ARTS AND SCIENCES
\$97M

SCHOOL OF VETERINARY MEDICINE
\$35M

SCHOOL OF ENGINEERING AND APPLIED SCIENCE
\$67M

SCHOOL OF NURSING

\$14M

RESEARCH AWARDS RECEIVED IN 2016

SCHOOL OF DENTAL MEDICINE

\$13M

One of the most imperative aspects of federal funding for research at Penn is that it provides the means to support long-term, fundamental research, explains Vijay Kumar, dean of the School of Engineering and Applied Science.

“You can think long term and take some risks,” he says.

Consider Kumar’s personal research focus, for example, which involves small robots that work together. The accelerometer, which enables them to tell what direction they are facing and how fast they are traveling, was originally pursued by the Department of Defense in an effort to build high-performance resonators for radios. Their usefulness in consumer electronics, especially smartphones, drove down their size and cost, but no one knew that they would enable the next generation of autonomous vehicles 20 years later.

“The path from designing this type of new technology, to drones or smart robots, has not been a straight path,” he says. “It involves twists and turns. There are so many serendipitous things that happen because of federal funding. It’s incredible.”

Jon Epstein, executive vice dean and chief scientific officer of the Perelman School

of Medicine, agrees with Kumar, adding that nothing could ever fully replace federal funding.

“I’m not just being sensationalist,” he says. “It would be a complete collapse of the biomedical research enterprise in the country if there were ever a dramatic cut in NIH funding.”

He explains how other forms of funding often come from donors who might want to support something that “will be a cure tomorrow.

“But the NIH has been good at taking a long-term view, and it pays off very well,” Epstein continues. “It’s how we’ve been able to keep ahead of other countries in the world and make all our lives better.”

In addition to helping develop new knowledge, federal funding allows researchers the capacity to train students, creating a new generation of talent.

“This is a major product for us,” Kumar says. “I train students and they go off and train other students. It has an exponential effect.”

And it’s not just graduate students who benefit. Kumar says Penn Engineering’s

CONTINUED ON PAGE 36

A 4,000-Year-Old Boat in the Middle of the Desert

The team discovered 150 pottery vessels buried with their necks facing the bunker's entrance. The pottery deposits date to about 1850 BCE.

When Penn archaeologist Josef Wegner and colleagues first came across structures buried deep beneath the sand at Abydos in Egypt, they anticipated finding more of a cemetery of forgotten pharaohs like the one they had discovered in 2014. Instead, in the middle of the desert, they found a huge vaulted building.

“We thought it might be a good prospect for a large royal tomb,” says Wegner, an associate professor of Egyptian archaeology in the Department of Near Eastern Languages and Civilizations in the School of Arts and Sciences and an associate curator at the Penn Museum. “We discovered it wasn’t a tomb at all, but a subterranean bunker for a boat.”

Within the cavity, the team found wooden planks now attributed to a boat that was part of the funeral procession for Pharaoh Senwosret III, who reigned around 1850 BCE.

They also discovered about 150 jars and 120 preserved boat drawings on the building’s walls.

“Originally, the building must have had hundreds and hundreds of boat drawings,” Wegner says. “They are phenomenal images, with a lot of detail showing the structure of the boats, the form of the hulls, masted and unmasted boats, rowers, and oars.”

Part of the discovery’s fascination comes from its location—about half a mile from the edge of the Nile River flood plain and about nine miles from the river itself. That means the boat moved mostly across land to reach its final destination.

In addition, Senwosret III constructed multiple tomb sites before his death, leading to the possibility that he was buried either in a pyramid in northern Egypt or in his Abydos tomb.



The vaulted underground building discovered by Josef Wegner and colleagues contained 120 preserved boat drawings on its walls, including those seen above.

“Senwosret III’s tomb at Abydos is one of the largest of its type in Egypt. It’s about 800 feet long, cut into the bedrock, lined with massive masonry blocks,” Wegner says. “A lot of evidence has come out that this was the king’s burial place, and the boat burial strengthens the case.”

Wegner says including a boat at a king’s final resting spot is a long-held tradition that ended not long after Senwosret III’s reign, though researchers don’t fully understand why. He’s hoping continued work at Abydos, including the excavation of nearby chambers that likely held other ceremonial equipment or further study of the nearby subterranean tomb, can provide some additional context.

“We may get some interesting clues from these wood fragments about the size and design of the boat itself,” Wegner explains. “Archaeology often involves piecing together tiny fragments of information.”

BRIEF CRIMINOLOGY



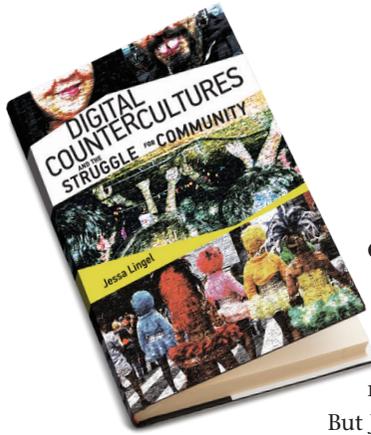
Marijuana Measured

How much marijuana does the average joint contain?

“It turns out to be a critical number in estimating how much marijuana is being consumed [nationwide], how much drug-trafficking organizations are putting on the market, and how much states might expect in revenue post-legalization,” says Greg Ridgeway, an associate professor of criminology and statistics in the School of Arts and Sciences.

Until now, there’s been no consensus on the issue, with different groups using varying baselines. Ridgeway and a RAND Corporation colleague turned to a 30-year-old drug-pricing model, plugging in information from more than 10,000 marijuana transactions during 11 years and from more than 40 communities.

Their conclusion: A single joint, on average, contains 0.32 grams of marijuana—much less than previously thought.



Often, when people talk about the internet, they focus on mainstream users. There are books about digital technology in the workplace, or how digital technology is changing romantic relationships, for instance.

But Jessa Lingel, an assistant professor at the Annenberg

HOW COUNTERCULTURAL COMMUNITIES USE THE INTERNET

School for Communication, has been dissecting a different story: how the web matters for people we don't typically talk about.

In "Digital CounterCultures and the Struggle for Community," Lingel presents three "outsider" case studies that contrast the imagined uses of the internet and all the messiness that goes with it. For more than five years, she examined an online body modification community, members of the underground punk music scene in New Brunswick, N.J., and performers in Brooklyn, N.Y.'s drag community. The three groups topple established norms of how digital technologies should be used, making the internet meet their individual needs.

"I actually didn't start doing this research with a plan of doing a book," Lingel says. "These groups had just come into my life and had been interesting to me, and I thought, 'How could I roll these into an analysis about the internet and power?'"

Lingel explains what Body Modification Ezine, an early adopter of personal blogging, online dating, podcasts, and wikis, has achieved as an online counterculture, and also how it has faltered, losing members as more mainstream social network sites emerged. She describes how and why the punk community in New Brunswick strives to keep its activities off the radar. And in Brooklyn, she notes, the drag community uses mainstream digital technologies, such as Facebook, for promotional purposes, but these tools sometimes fail to accommodate their complex lives.

With in-person interviews forming the bulk of the evidence for her book, Lingel draws themes between the different groups that include membership boundaries, collective rulemaking, secrecy and privacy, otherness or "alterity," and performativity.

By exploring the ways the internet supports or doesn't support countercultural or marginalized communities on the web, we're able to be "more deliberate, thoughtful, and intentional" when thinking of new uses of tools and platforms we use in everyday life, says Lingel.

"Ultimately," Lingel writes in her introduction, "what is at stake in this book is the radical potential for addressing gaps of power and privilege through the (re)discovery of the internet's depth, breadth, and strangeness."

The Politics of Talking About Race

"Governing with Words: The Political Dialogue on Race, Public Policy, and Inequality in America," a book by Daniel Q. Gillion, a professor of political science in the School of Arts and Sciences, revisits a debate that has existed in political science, sociology, history, and many other disciplines for generations: Is talking about race helpful or hurtful?

"That has been the debate for a long time," Gillion says. "It's race-conscious policies versus race-neutral policies, and what's the best approach?"

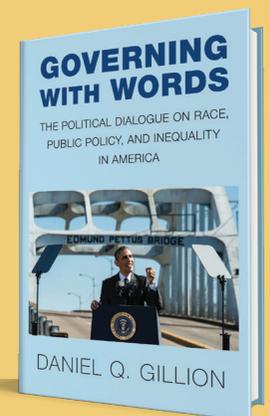
Within the past decade, the debate has returned to the forefront due to the election of former President Barack Obama, who Gillion says did not always feel comfortable addressing issues and concerns in America through an explicit discussion of race, particularly during his first term in office.

"[President Obama] felt like if he spoke about race, he would ostracize individuals and he would receive a negative blowback and a pushback, and that would hurt his approval rating and hurt his ability to pass policy," Gillion says.

"Governing with Words" investigates whether there is factual evidence to support the notion that talking about race can be hurtful to political causes and provides empirical, quantifiable data that determines the statement is often untrue.

"Theoretically, I don't believe that it's the case that discussing race in government leads to a negative result because I believe that words can be empowering," Gillion says. "You can persuade colleagues and you can persuade individuals."

Gillion looked at every statement made by presidents going back to 1955, as well as those made by Congressional leaders going back to 1990, and then



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Data Helps Determine Philadelphia Locations Most in Need of Pre-K

Children living in poverty are disproportionately exposed to numerous risks, from homelessness to maltreatment—all of which adversely affect their development. Early education can reduce those risks, which was one of the motivations behind Philadelphia Mayor Jim Kenney’s proposal to create a pre-kindergarten program for all 3- and 4-year-olds in the city.

But the city faced a tough question: Where should these pre-K programs be located?

As the poorest of the 10 largest cities in the United States, Philadelphia has many neighborhoods in need. The Penn Child Research Center team, led by John Fantuzzo, a professor in the Graduate School of Education, used data to help the city’s Universal Pre-K Commission determine locations for programs where the most vulnerable children could benefit from access.

Fantuzzo, along with executive director of the Penn Child Research Center Katherine Barghaus, and the Center’s team of researchers—Ben Brumley, Kristen Coe, Casey Henderson, and Whitney LeBoeuf—used an Integrated Data System (IDS) approach to social problem-solving, a method that is tailored to the realities of government. The robust nature of this approach allowed the Penn Child Research Center team to study populations across public agencies and in real time. In partnership with the City of Philadelphia’s Data Management Office, which runs the city’s IDS, the team identified neighborhoods with high concentrations of children exposed to multiple risks, places where there are low concentrations of quality child care slots, and neighborhoods most in need of pre-K.

While Barghaus says they had a good sense of what to expect from the risk literature, the segregation of disadvantage was still shocking.

Specifically, 21 percent of 3- and 4-year-old children in the city experienced more than one early risk, and in some neighborhoods, that number rose to 43 percent. The team highlighted 23 neighborhoods with high rates of children living with multiple risks and below-average rates of pre-K slots.

This information was used as part of the process of determining locations of the first phase of pre-K programs and to conduct outreach efforts in neighborhoods with the most at-risk children.

Fantuzzo says the process has been a collaborative one, demonstrating the efficacy of the IDS approach.

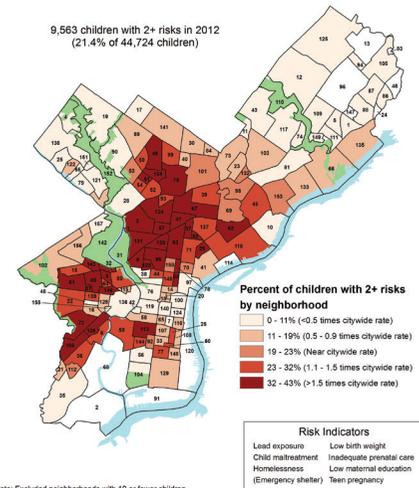
“It provided a clear, clean, face-valid exemplar of the approach to make visible needs and resources and brought those together for actionable intelligence,” he says.

This policy research work will continue with the city through the Penn Futures Initiative, in which researchers in Penn’s schools of Education, Social Policy & Practice, and Nursing will work to improve the lives of children and families. This cross-school, interdisciplinary team will continue to partner with the city and use IDS to raise awareness of and be responsive to the social problems facing vulnerable young children and families, and foster greater dialogue among city agencies, families, and community organizations.

Researchers identified neighborhoods in Philadelphia with at-risk kids and high-quality child care.

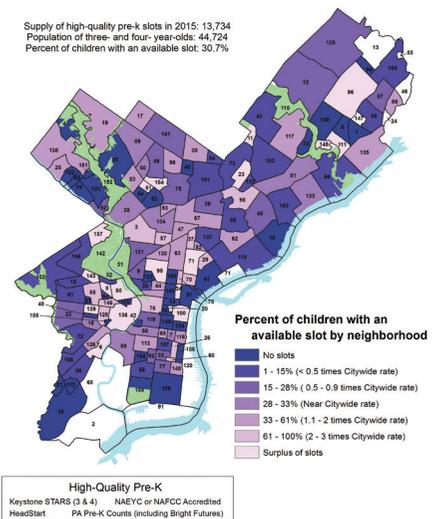
Multiple Early Childhood Risks in Philadelphia: Three- and four-year-olds with two or more risks

9,563 children with 2+ risks in 2012
(21.4% of 44,724 children)



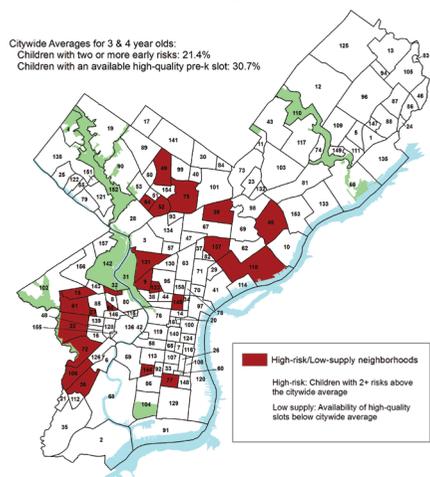
Supply of High-Quality Pre-K in Philadelphia: Slots for three- and four-year-olds

Supply of high-quality pre-k slots in 2015: 13,734
Population of three- and four-year-olds: 44,724
Percent of children with an available slot: 30.7%



High-Risk Philadelphia Neighborhoods with Low Supply of High-Quality Pre-K Slots

Citywide Averages for 3 & 4 year olds:
Children with two or more early risks: 21.4%
Children with an available high-quality pre-k slot: 30.7%



A LINK BETWEEN TIRED TEENS AND CRIME

In the late 1970s, Adrian Raine, then a doctoral student in the United Kingdom, asked 101 students in secondary schools to rate how tired they felt during the day. In 1993, a search at London's Central Criminal Records Office showed that the teens who reported daytime drowsiness were 4.5 times more likely to commit violent offenses later in life.

"It's the first study to our knowledge to show that daytime sleepiness during teenage years is associated with criminal offending 14 years later," says Raine, the Richard Perry University Professor of Criminology, Psychiatry, and Psychology, with appointments in the School of Arts and Sciences and the Perelman School of Medicine.

After seeing recent studies linking sleep problems to antisocial behaviors like disobedience and fighting, Raine decided to work with his former Ph.D. adviser, Peter Venables, to analyze data he collected as part of his dissertation research 39 years ago. Venables was an emeritus professor at the University of York, in the United Kingdom.

The study's data represents both their first project together and their last, as Venables passed away at the age of 94 just a few months after the study appeared in the *Journal of Child Psychology and Psychiatry*.

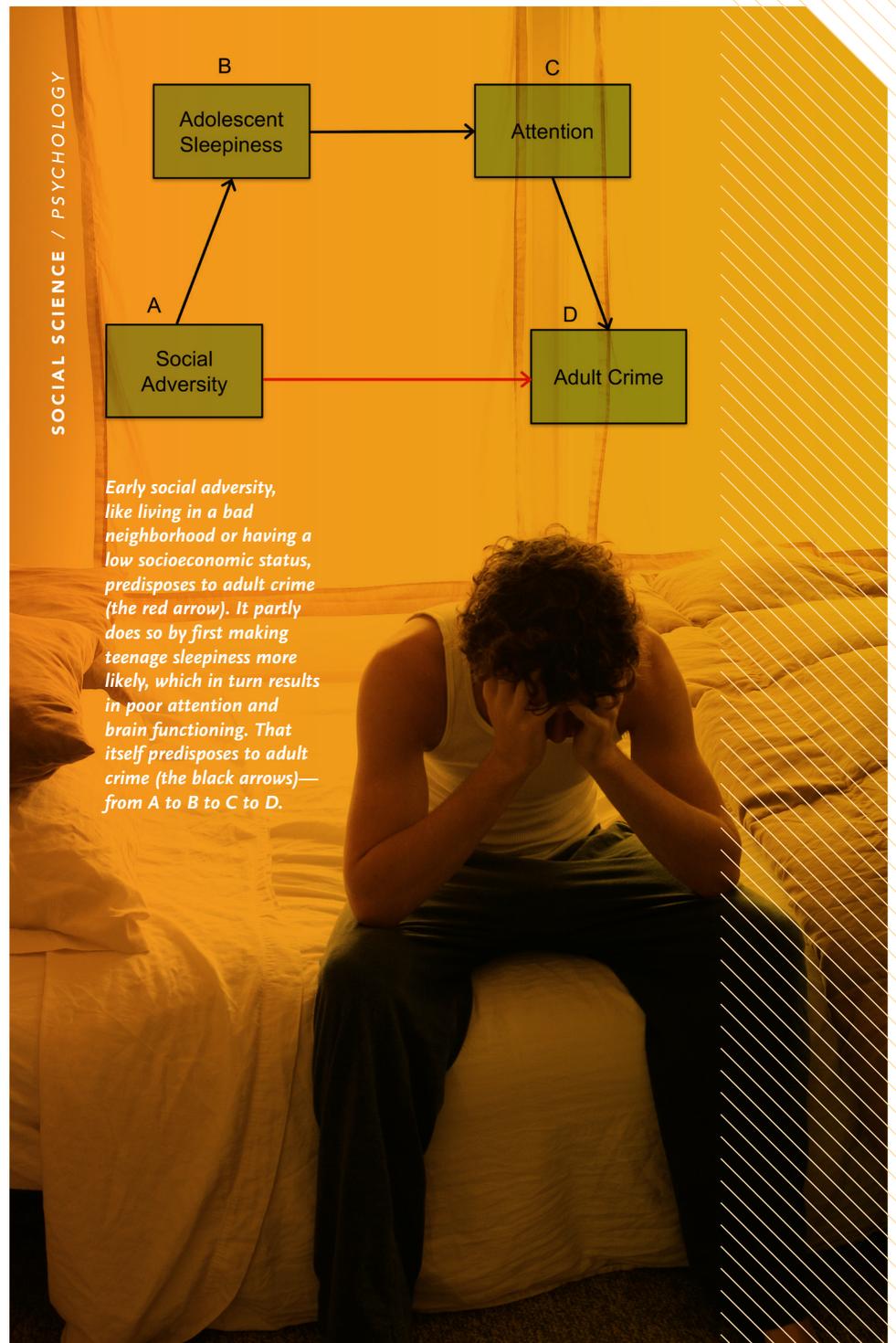
Besides self-reported sleepiness, Raine and Venables also incorporated other measures into their study to establish causality between lack of sleep and crime. By asking both the participants and their schoolteachers about antisocial behavior, they were able to control for this known predictor of future criminal behavior. Measuring sweat in response to a hearing test allowed them to gauge attention, which serves as a proxy for brain function.

After integrating these data points with the students' socioeconomic status, the researchers were able to establish a series of connections between social adversity, sleepiness, poor attention, and criminal behavior.

"Think of a flow diagram from A to B to C to D. Think of a chain," Raine says. "There is a significant link."

While it is a fact that better sleep improves school performance, the study suggests that it could also improve the odds of a crime-free adult life.

"Nobody's ever talked about better sleep for criminals," Raine says.



The opioid crisis has touched every sector of American society.

Veterans of recent wars are disproportionately affected and especially vulnerable, suffering chronic pain with high levels of stress resulting from undiagnosed and untreated combat trauma.

A report from the Center for Ethics and the Rule of Law (CERL) at Penn, an interdisciplinary institute that promotes the rule of law in 21st century warfare and national security, studies the connection between opioid abuse and the mental health challenges borne by those who served.

Produced by a team of veterans, attorneys, mental health professionals, and policymakers, “The Intersection of Opioid Overuse and Veteran Mental Health Challenges” provides an overview of the opioid epidemic among veterans, the over-prescription of opioids by the Veterans Administration and other health care providers, and the dangers of prescribing opioids to individuals suffering from post-traumatic stress injury (PTSI).

CERL Faculty Director Claire Finkelstein, a professor at the Law School and a professor of philosophy in the School of Arts and Sciences, says there is a cycle of veterans with fairly high levels of chronic physical pain seeking treatment for relief of their physical pain without getting assessed for possible PTSI.

“They get treated with opioids, but because they have antecedent trauma, and because their pain is chronic pain rather than using opioids in, for example, a post-operative setting for a few days, they very quickly become addicted,” she says.

Finkelstein says it is very easy for veterans who are suffering from combat trauma or other kinds of war-related injuries to use opioids they are prescribed for chronic physical pain to mute psychological pain.

The report provides recommendations for policy reforms to address opioid abuse among veterans, such as using extreme care in prescribing opioids to veterans and providing access to treatment.

The psychological impact of war on veteran communities has ripple effects for the larger society. Veterans experience higher rates of divorce, unemployment, and homelessness. Substance abuse, and in particular addiction to opioids, amplifies these problems, Finkelstein says.

There is a growing awareness of the crisis at the Veterans Administration, Finkelstein says, and there has been a concerted effort on the part of state and local governments to work toward a solution.

“The crisis cannot be overstated,” she says. “Veterans have been committing suicides at astronomical rates, on the level of 22 veterans a day killing themselves. It just really bears witness to the level of psychological distress that those who have been in these conflicts experience.”

Opioid Abuse and the Trauma of War

Cash Bail Can Be Unjust



LAW
SOCIAL SCIENCE

A person arrested and charged with a crime is usually brought before a magistrate, who sets the terms of his or her bail.

If the accused individual can afford to pay bail, he or she is released until the next court date. If the person cannot make bail, he or she must remain imprisoned until the date of trial, which could be weeks or months.

Individuals detained pre-trial for low-level crimes and unable to pay bail face some potentially life-altering decisions. They can remain in jail until trial, or they could take a plea deal, even if they are innocent, which would, in many cases, allow them to go free.

“It can be very hard to turn that down,” says Paul Heaton, academic director of the Quattrone Center for the Fair Administration of Justice at the Law School, “even if you are, in fact, innocent.”

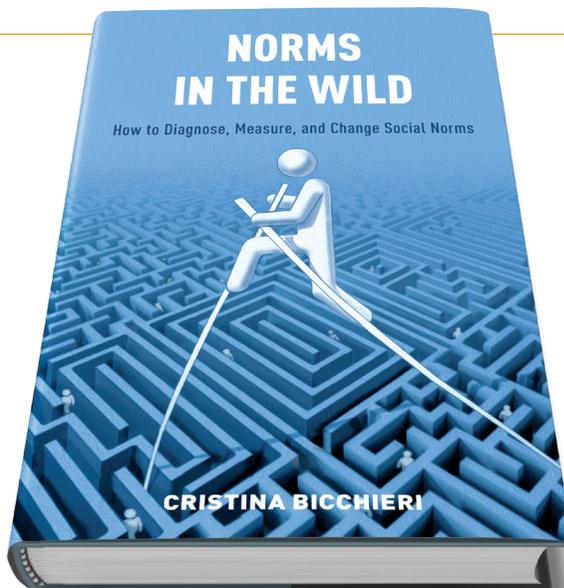
Research from the Quattrone Center reports that defendants unable to make bail are more likely to be convicted and less likely to receive favorable plea terms than similarly situated defendants who make bail, and they also go on to commit more crimes after their release.

One study, conducted by Heaton and Quattrone Center fellows Sandra Mayson and Megan Stevenson and published in the *Stanford Law Review*, investigated the effects of misdemeanor pretrial detention in Harris County, Texas. The researchers found that misdemeanor defendants who were unable to make bail were 25 percent more likely to plead guilty and 43 percent more likely to be sentenced to prison and received sentences more than two times longer than similar released defendants.

In a second study, Stevenson analyzed pre-trial detention in Philadelphia for all criminal cases that had a bail hearing between Sept. 13, 2006, and Feb. 18, 2013. She found that felony and misdemeanor defendants unable to make bail were 13 percent more likely to be convicted and received sentences five months longer than equivalent defendants who were not detained pre-trial.

Defendants who plead guilty to a crime they did not commit do so for the short-term gain of freedom, but Stevenson says they often overlook the long-term implications a conviction can have for immigration, child custody, student loans, housing eligibility, future employment prospects, and access to various public services.

Heaton says alternatives to a cash-based bail system include using risk assessment to identify defendants who pose the greatest risk of fleeing or committing another crime, releasing non-violent defendants on their own recognizance, requiring an individual to check in with a pre-trial services officer regularly, or using GPS or other forms of electronic monitoring.



SOCIAL SCIENCE / PHILOSOPHY

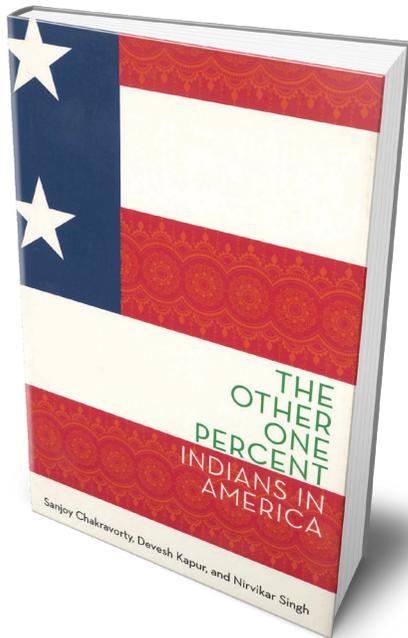
Diagnosing and

In the 2015 Mexican telenovela “*Simplemente María*,” the protagonist is an average woman and single mother. But when she procures a sewing machine, learns to sew, and works her way up in the fashion industry, she can soon support her family.

“*María*,” who has become a role model for a particular subset of women, is one example in Cristina Bicchieri’s book “*Norms in the Wild: How to Diagnose, Measure, and Change Social Norms*.” The text follows her 2006 tome on social norms and aims to teach non-academics how to understand, measure, and change ingrained societal behaviors.

“Soap operas are an interesting [path] to behavioral

INDIAN IMMIGRANTS' SUCCESS IN PURSUING THE AMERICAN DREAM



People of Indian origin make up about 1 percent of the U.S. population, a number that, while small, has increased rapidly in recent years. In 2014, India was the largest source of new immigrants to the U.S.—more than China or Mexico.

“More Indian immigrants have obtained permanent residence in the last 15 years than in the entire 20th century,” says Devesh Kapur, professor of political science in the School of Arts and Sciences and director of the Center for the Advanced Study of India.

This story—one of swift growth and marked success—is the subject of Kapur’s latest book, “The Other One Percent,” written with Sanjoy Chakravorty from Temple University and Nirvikar Singh of the University of California, Santa Cruz. They explore how a population from one of the poorest countries in the world, with distinct linguistic and religious characteristics, became the most educated and economically successful immigrant group in the U.S. in a little more than one generation.

Kapur and his coauthors uncovered a story of triple selection: first, a social selection, where some groups (“high/dominant” castes) have greater access to education; second, an exam-based selection within India; and third, an entry selection, with the U.S. immigration system favoring STEM (science, technology, engineering, and math) fields. As a result, immigrants from India command higher than average salaries and are able to move to wealthier neighborhoods. The average income of Indian immigrants, for example, is higher than the average income in every state.

How people come to the U.S. has made a big difference, as well, says Kapur. A larger fraction of immigrants from India arrive with work visas—compared to family reunification or refugee or asylum visas—so they are better integrated into labor markets.

“It’s obvious [this success] has nothing to do with being Indian, because if that were the case, we argue, India should’ve been far richer—and they would not be leaving in the first place,” Kapur says. “It’s just who comes from India.”

Immigration from India happened in three phases, the researchers report: Doctors and engineers largely came after the Immigration and Naturalization Act of 1965 to the late-1970s; families joined after the first wave during the next two decades; and subsequently, the information technology boom that began in the late 1990s led to a burgeoning third wave of immigrants.

The current Indian immigrant population is about 4 million, more than double the number at the beginning of the century. But with uncertainty about restrictions on employment-related visas, Kapur says it is difficult to project the future.

“We cannot take the last 15 years at all to tell us what the next 15 years will be,” he says.

“It’s obvious [this success] has nothing to do with being Indian, because if that were the case, we argue, India should’ve been far richer.”

Changing Social Norms

change,” says Bicchieri, the Harvie Professor of Social Thought and Comparative Ethics in the School of Arts and Sciences. “It’s much easier for people to identify with characters who are similar to them.”

The book summarizes five concepts starting with the most basic: How do you “diagnose” a collective behavior?

“Is it a custom? A descriptive norm or a social norm?” Bicchieri asks. The objective is to get at the underlying reasons for people’s actions. Measuring social expectations—and whether behavioral preferences depend on them—answers these questions.

Chapters that focus on measurements and tools

for change grew out of Bicchieri’s lab research that led to a new operational, measurable definition for social norms. Working with NGOs and international organizations, she also tweaked the process to work beyond a laboratory’s borders, incorporating cases like child marriage and open defecation.

Laws against marrying someone younger than a certain age work only if the community buys into it, she explains. The same goes for paying families to build a latrine instead of using the street as a toilet. In this context, monetary incentives may not work.

Bicchieri closes by explaining how social norms emerge, either out of simple customs that come to

signal a group’s identity, or by solving social dilemmas. She also discusses the role of trendsetters within communities who help initiate new behaviors and abandon established, harmful ones. Here she returns, once again, to soap operas as “trendsetters” that offer a way to scale up interventions.

“Soap operas show that new behavior is possible, that new behavior will go through hurdles but in the end will succeed,” she says. “They let people believe they can aspire to a better life, and that that life is attainable.”

Shakespeare and His (Uncredited) Coauthors

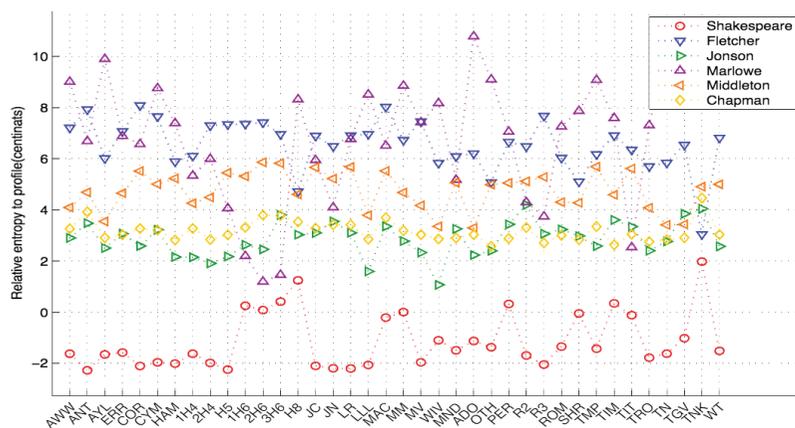
Four hundred years after the death of William Shakespeare, enduring questions remain about whether he had an uncredited cowriter on some of his world-famous plays.

A team of Penn researchers has found an answer—in the School of Engineering and Applied Science, of all places.

Alejandro Ribeiro, an associate professor at Penn Engineering, along with lab members and network engineers Santiago Segarra and Mark Eisen, and Gabriel Egan, a professor of Shakespeare studies at De Montfort University in the United Kingdom, created an algorithm for author attribution that determined that Shakespeare did, in fact, have a coauthor on many of his plays.

To reach this landmark conclusion, Ribeiro and his research team used “word adjacency networks,” a way of analyzing a piece of text to determine unique, hidden characteristics of its writer or writers.

The word adjacency networks are based on function words such as “to,” “and,” “or,” “one,” and “the”—words writers must use to construct a sentence. The researchers’ algorithm counts word adjacencies, or how often and how closely different sets of function words appear in a text. Since all writers must use these words no matter what they are writing about, they are a consistent way of comparing different authors’ writing styles.



To reach their landmark conclusion, Alejandro Ribeiro and his research team used “word adjacency networks,” a way of analyzing a piece of text to determine unique, hidden characteristics of its writer or writers.

Ribeiro and colleagues built word adjacency networks for all of Shakespeare’s plays and combined them to create a Shakespeare profile. They fashioned similar profiles of the works of Shakespeare’s contemporaries, including Christopher Marlowe, Thomas Middleton, Ben Jonson, George Peele, and John Fletcher. The researchers then combined all of the texts from every candidate into a single profile to create, more or less, an average fingerprint for English-language authors of the Shakespearian era.

Analysis of Shakespeare’s author profile suggests that he was not the only author of three “Henry VI” plays, which were most likely a collaboration between Shakespeare and Marlowe or Peele.

Ribeiro says the case of “Henry VI” and Marlowe is particularly important because it is one of Shakespeare’s earliest plays and prior to Shakespeare, Marlowe was one of the most established writers of his time.

“This collaboration could be evidence of Shakespeare at least looking up to Marlowe,” he says. “We know now that Marlowe played an important role in Shakespeare becoming Shakespeare.”

The discoveries by Ribeiro and his team were published in the journal *Shakespeare Quarterly*. Partly because of their research, the “New Oxford Shakespeare Complete Works” will identify Marlowe as Shakespeare’s coauthor for the three “Henry VI” plays.



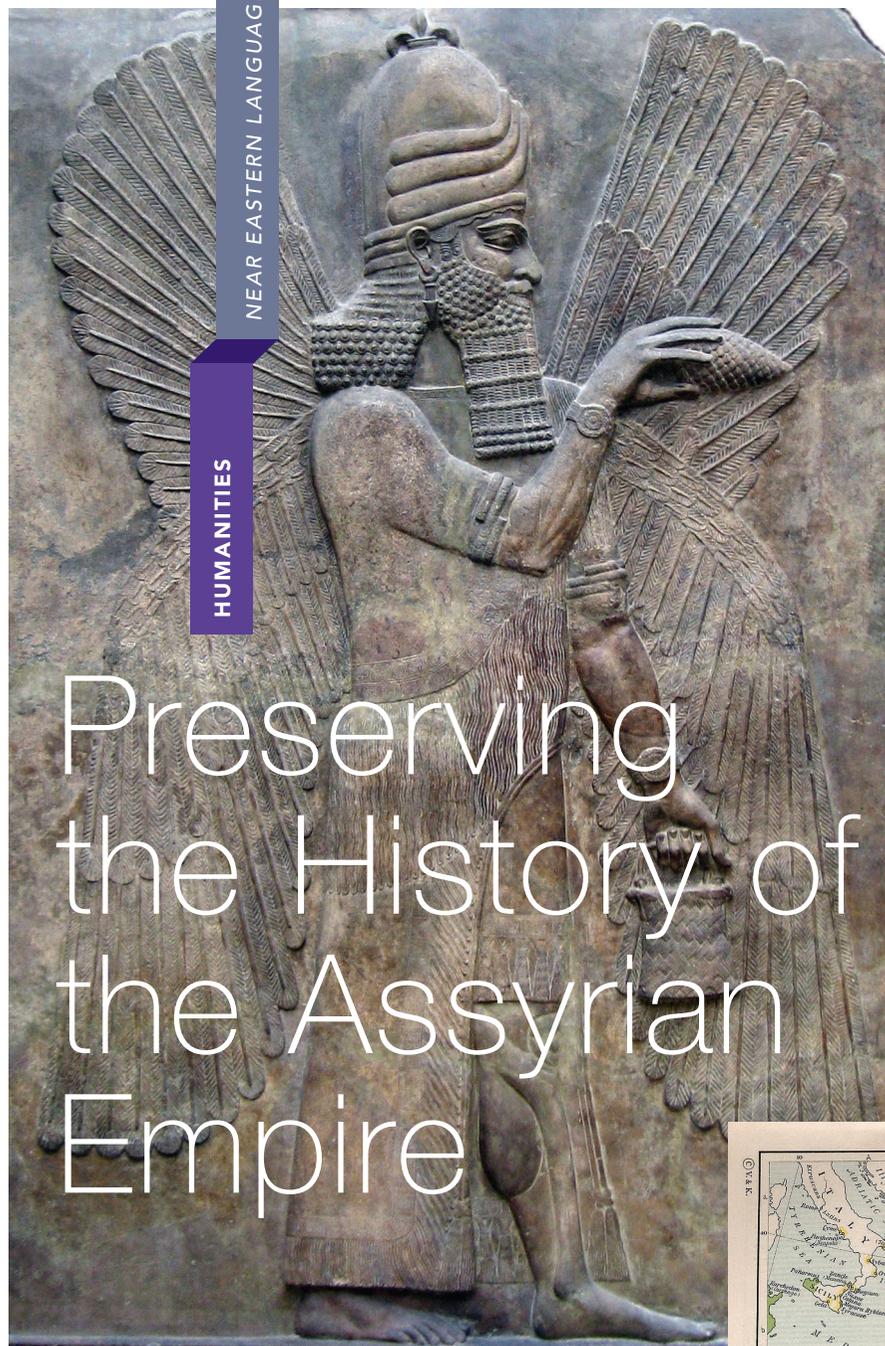
Bringing New Literary Works to Light

In 2017, Penn scholars unearthed hidden literary gems and translated works for new audiences.

Jean-Christophe Cloutier, an assistant professor of English in the School of Arts and Sciences, discovered a previously unknown novel from Harlem Renaissance writer Claude McKay in 2009. Cloutier co-edited a scholarly edition of the book, which places the novel in historical context and discusses how this work might affect knowledge of McKay and the African-American response to the 1935 Italian invasion of Ethiopia.

Cloutier also edited the lost French writings of Jack Kerouac in the volume “La vie est d’hommage” and subsequently translated two of the French novels, originally written in 1951 and 1952. “The Unknown Kerouac: Rare, Unpublished & Newly Translated Writings” includes the novels “The Night Is My Woman” and “On the Road: Old Bull in the Bowery,” which Cloutier translated into English for the first time.

Robert Frost enthusiasts can hear previously unreleased recordings—including his 1937 Pulitzer Prize dinner speech and his readings of “The Road Not Taken,” “Birches,” and “Mending Wall”—on PennSound, the web-based archive at the Center for Programs in Contemporary Writing. The recordings, made in 1933 and 1934, were discovered by Ph.D. student Chris Mustazza.



Preserving the History of the Assyrian Empire



Amidst the Islamic State's destruction of historical sites and artifacts in Iraq and Syria,

Grant Frame, an associate professor of Assyriology in the School of

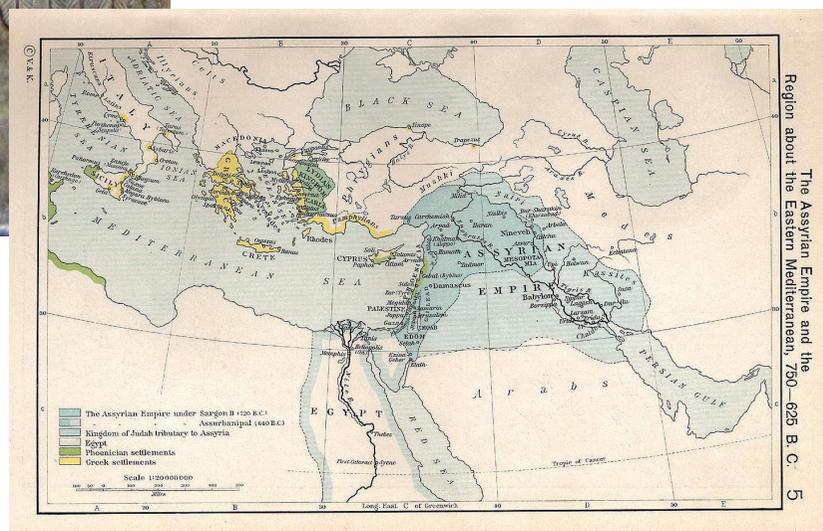
Arts and Sciences, is leading an international team translating royal inscriptions of the region's ancient empires. Their ultimate goal is to increase the understanding of Assyrian and Babylonian history.

Frame has received a National Endowment for the Humanities (NEH) grant for 2017–19 for his Royal Inscriptions of the Neo-Assyrian Period Project. Funded under the NEH Division of Preservation and Access, the project makes available historic materials from Iraq and Syria, some of which came perilously close to being destroyed by ISIS.

“What we’re trying to do is preserve and make accessible information about the history of the Assyrian Empire. At the time, it was the largest empire the world had ever seen,” Frame says.

His project currently consists of four volumes. The grant will enable Frame and his research team to add three additional volumes and complete the project.

Ancient Mesopotamian rulers had countless inscriptions written in the Akkadian language and the cuneiform script, ranging from short one-line



inscriptions to lengthy, detailed inscriptions of more than 1,300 lines. Thousands of these texts have been discovered preserved on clay tablets, prisms, and cylinders, stone statues and wall slabs, and numerous other artifacts from Iraq, Syria, Iran, Turkey, and additional parts of the Middle East.

Composed between 744 and 609 BCE, the royally commissioned texts being edited by Frame and his team provide rich history lessons on the lives of ancient Assyrian and Babylonian kings, as

The project will provide rich history lessons on the lives of ancient Assyrian and Babylonian kings, as well as Israelite and Judean kings of the Hebrew Bible and rulers such as King Midas.

well as Israelite and Judean kings of the Hebrew Bible and rulers such as King Midas, who appears in classical texts.

“One of the volumes to come describes the exile of the lost 10 tribes of Israel,” Frame says.

He and his research team are editing and translating into English all of the known royal inscriptions of the Neo-Assyrian kings from the reign of Tiglath-pileser III (744-727 BCE) to that of the last Assyrian ruler, Ashur-uballit II (611-609 BCE).

Four books have been published so far. Additional books will include the official inscriptions of Sargon II (721-705 BCE), Ashurbanipal (668-c. 631 BCE), and those of his successors, up until the fall of Assyria.

“One of the books will describe Ashurbanipal’s training to become a king,” Frame says.

He adds that some of the inscriptions describe “the hunting of lions, the building of temples for various gods, and campaigns into [what is now] Iran and Turkey, through mountainous terrain where trees were so thick you couldn’t see the sun.”

THE HISTORY OF JAPANESE FEMINIST DEBATES

Throughout the past century, Japanese feminists have worked tirelessly to give voice to the frustrations and obstacles, both large and small, that limit women from living happy lives.

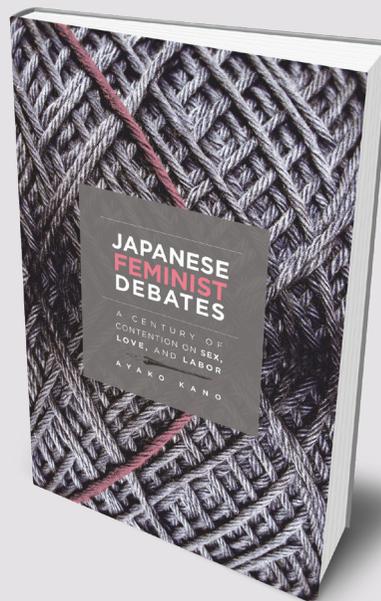
Ayako Kano, a professor in the Department of East Asian Languages and Civilizations in the School of Arts and Sciences and a core faculty member in the Gender, Sexuality, and Women’s Studies Program, spent more than a decade researching 100 years’ worth of material representing competing voices defining happiness and unhappiness for women in Japan. Her newest book, “Japanese Feminist Debates: A Century of Contention on Sex, Love, and Labor,” gives shape and coherence to her findings.

“I see the status of Japanese women as such a paradox,” Kano says. “Japan is a very developed, advanced, industrialized country, and yet in the status of women—when you take certain kinds of measures, such as women in leadership positions in corporations and politics, and so on—it ranks very, very low. But it ranks high for education, health, and longevity of women.”

Kano’s book dives into debates on sexuality, reproduction, motherhood, and work and investigates the backlash and backpedaling related to debates on state feminism.

“There are issues on which reasonable and thoughtful people can disagree, and it’s worth remembering the history of those disagreements,” she says.

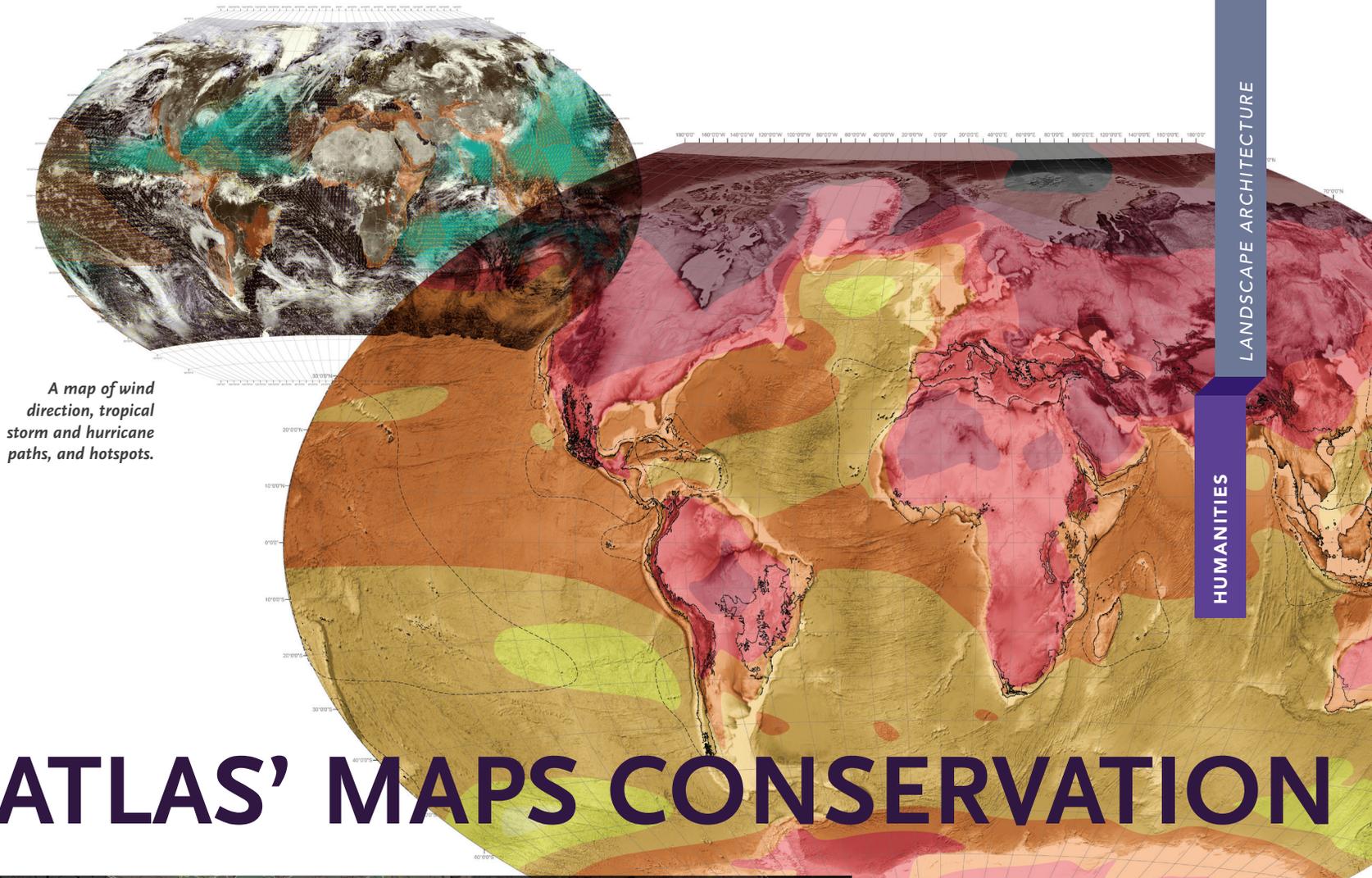
Part of what Kano argues is that, when considering definitions of “equality” or “happiness,” or even the question of “What do women want?” the answers get very contentious, very quickly.



“You’d think there would be a feminist position on A, B, and C, but it turns out people who define themselves as feminists are really split on many things,” she says.

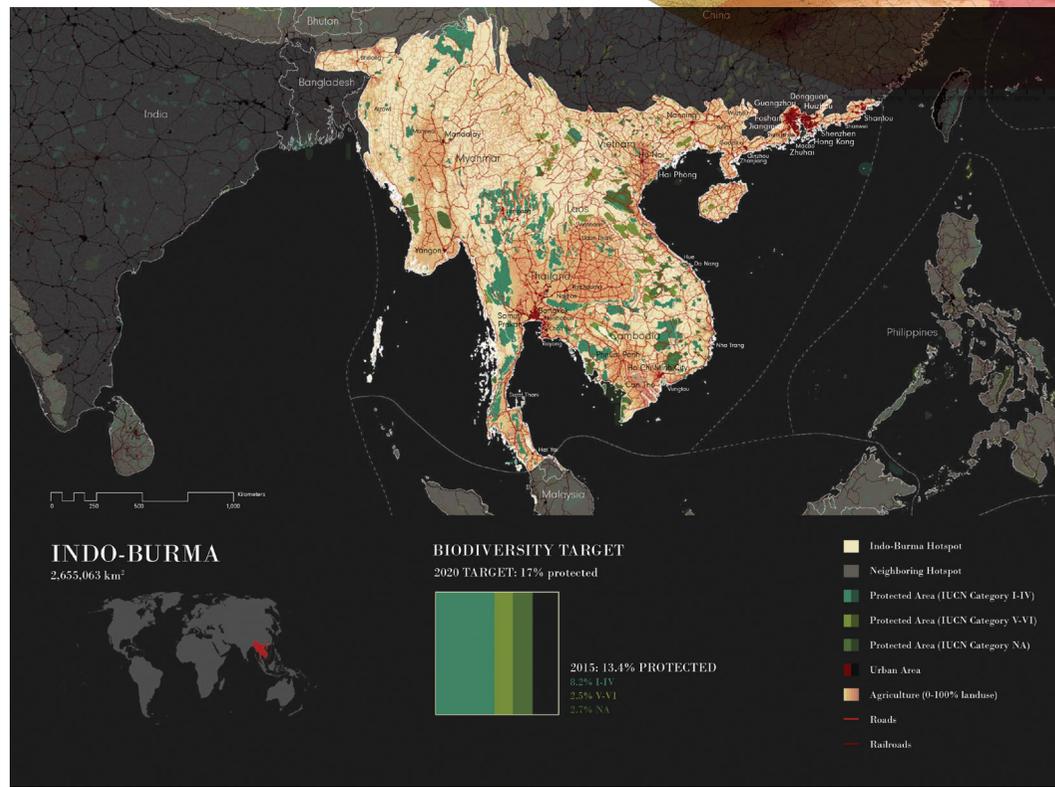
In the book’s epilogue, Kano presents her thoughts on women’s future happiness in Japan.

“I’m a cultural historian so I’m more comfortable looking toward the past, but I wanted to explain how, given the way things look now, what are the possibilities for the future?” she says. “Given the various demographic and geopolitical challenges ahead, it’s likely that debates will continue.”



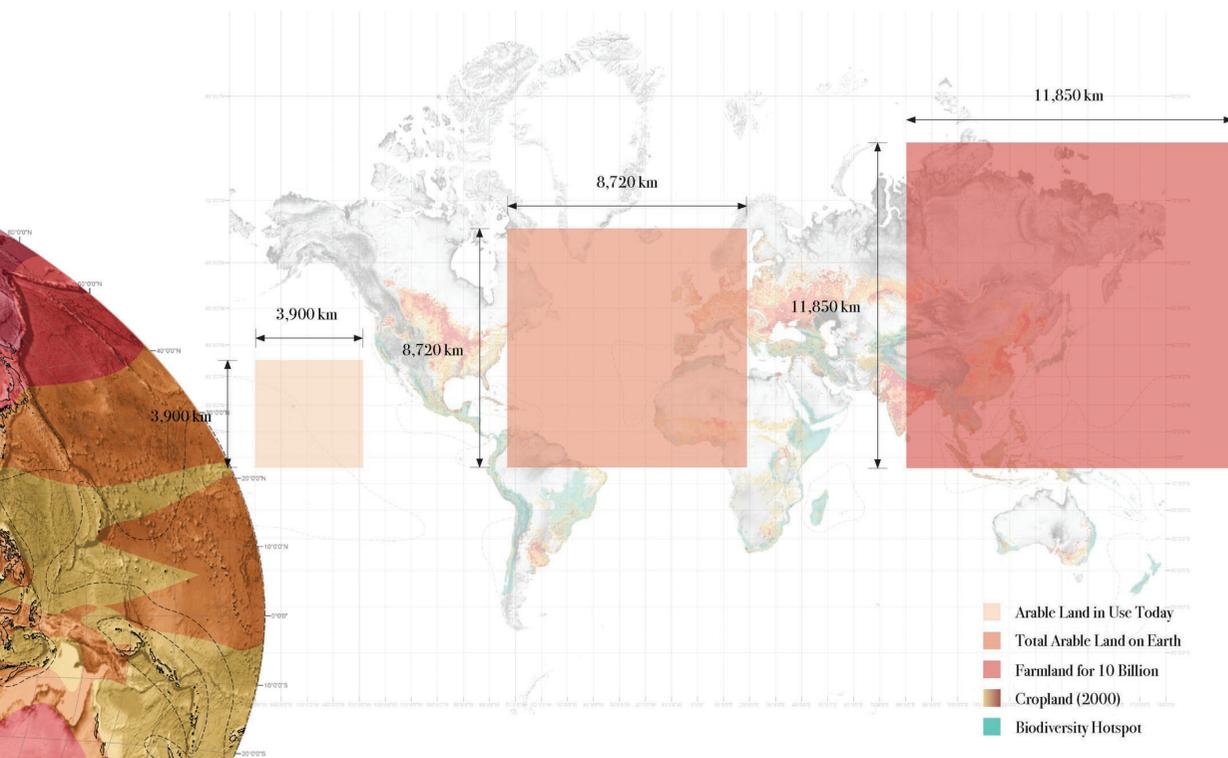
A map of wind direction, tropical storm and hurricane paths, and hotspots.

'ATLAS' MAPS CONSERVATION



Global average temperature change, projected for 2081-2100, based on 1986-2005 temperatures. Pinks and reds indicate more change.

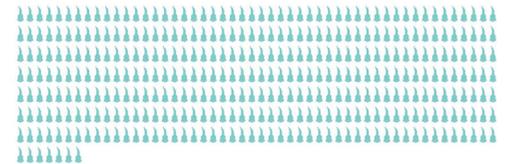
This hotspot map of the Indo-Burma region shows protected areas in green.



From left, croplands in 2015, land with potential for crop production, and farmland for 10 billion people, if they consume what the average American does today.



NYC X357
425 NEW YORK CITY'S TO BE BUILT PER YEAR



WINS AND THREATS

By 2100, it's possible that 3 billion more people will live in cities than do today. The pressure to ensure this expansion does not wipe out crucial biodiversity has never been greater.

Richard Weller, the Martin and Margy Meyerson Chair for Urbanism, a professor and chair of the Department of Landscape Architecture in the School of Design, and a fellow in the Penn Institute for Urban Research, has led an effort to identify where these biological resources are most at risk. The result is the “Atlas for the End of the World.”

Freely accessible online, the Atlas documents land use, urbanization, biodiversity, and conservation progress worldwide. Its aim is to harness and present key data in a visual format that governments, non-governmental organizations, urban planners, and landscape architects can use to enact better conservation and planning on the ground.

“What’s extraordinary is that over the course of the last 50 years, the conservation community has managed to protect 15 percent of the planet,” says Weller. Under the United Nations Convention on Biological Diversity, the global target is 17 percent.

To determine the progress toward this goal, Weller and his students used their expertise in mapping techniques and familiarity with global datasets to focus particular attention on ecological hotspots—areas rich with species that cannot be found anywhere else.

The team found that 21 of 36 recognized ecological hotspots worldwide have so far failed to meet the 17 percent target. In addition, these repositories of diversity are on a collision course with urban development. Weller and his team found that more than 90 percent of cities in hotspots are forecast to sprawl into high biodiversity areas.

Weller and colleagues are now zooming in on a few dozen of these cities to get a more detailed picture of whether and how biodiversity is being accounted for in urban planning. They are also in talks with the United Nations to see how to move their findings forward.

Though the outlook for the co-existence of human and non-human life on Earth can seem daunting, Weller hopes that insights from the Atlas will inform planning going forward.

“This is laying the groundwork for us to work with some of these cities and get involved with more creative approaches to making future growth sustainable,” Weller says. “In reality, it’s not the end of the world at all, but the beginning of an urbanized world where growth must be designed and planned if biodiversity is going to be sustained.”

Estimates say the world population may increase by 3 billion in 2100 and most people will live in cities. To accommodate them, 357 New York Cities will need to be constructed.

THE BAD AND GOOD OF BACKUP PLANS

BUSINESS / OPERATIONS

Young adults aiming to join the workforce are often advised to work hard, stay focused, and follow their dreams—but also have a backup plan, a “Plan B” in case “Plan A” fails.

New research from the Wharton School disputes this seemingly sage advice and finds that contemplating a backup plan can have a negative effect by causing people to work less vigorously toward their No. 1 goal.

The project was led by Jihae Shin, a former Ph.D. student at Wharton, and based on her personal experiences. She showed up one day in the office of Katherine Milkman, the Evan C. Thompson Endowed Term Chair for Excellence in Teaching at Wharton, stressed out about the job market for aspiring college professors. Shin believed her best approach was to solely concentrate on trying to get a job as a professor. She felt that if she allowed herself to think about a position outside of academia, she wouldn't work as hard to get the professorship.

Shin, now an assistant professor at the University of Wisconsin-Madison, approached Milkman with an idea for a research project based on her dilemma, and Milkman enthusiastically approved.

“Mostly, we tell people about not putting all their eggs in one basket because whenever we're trying to achieve a goal, there's some risk, and we want to have a backup plan,” Milkman says. “But what she was pointing out is that there's this danger of even thinking through a backup



“If the world conquest thing doesn't work out, my fall-back plan is business school.”

plan, which is it can reduce your motivation, your desire for the primary goal.”

Shin designed a series of studies that involved people completing effortful tasks. If they performed well, they would get a reward. Certain individuals were randomly prompted to think through another way to get the same reward with inferior performance. The people assigned to think through alternative paths to the reward performed worse on the tasks, and their desire to achieve the primary goal also lessened.

“What we see is that the performance is lower when people have thought through a backup plan,” Milkman says. “Goal desire is also lower, and that's driving the effect.” Their study was published in *Organizational Behavior and Human Decision Processes*.

Milkman says their findings only apply to goals whose success depends upon effort, such as graduating from college. The researchers are not saying a person should never have a backup plan.

“Probably upward of 90 percent of the time you should have a backup plan,” Milkman says. “But if you're ever in a situation where it requires all-out effort, then you should at least consider the downside of having one and consider forgoing it.”

The Fortune Makers

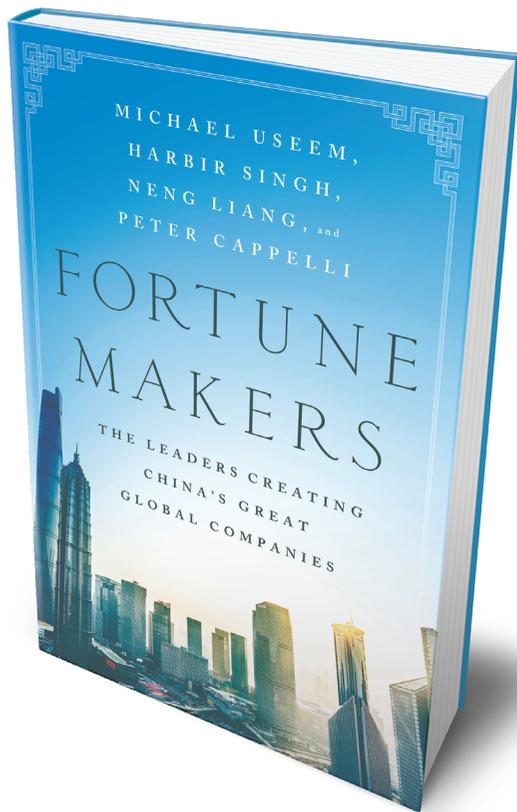
If you walk into a Walmart store, there's a 70 percent chance you'll purchase a Chinese product. Have a Lenovo computer, or a small refrigerator made from Haier? What about a Volvo? Soon enough, you might even be traveling on the Commercial Aircraft Corporation of China, or Comac—a direct competitor to the Boeing 737 and Airbus A320.

For all these reasons and more, the Wharton School's Michael Useem says, “we have to understand who's behind the making of these products, and how they are doing it.”

Throughout the past 30 years, China has witnessed stunning economic development. Using state capitalism, the country pulled 600 million people out of poverty. It is on track to soon be the largest economy in the world.

Changes in government policy and practices made the transformation possible, and the restructuring of state-owned enterprises has had an enormous effect, Useem notes, but credit is also due to a group of Chinese entrepreneurs and executives leading the way.

In “Fortune Makers: The Leaders Creating China's Great Global Companies,”



of China

Useem, director of Wharton's Center for Leadership and Change Management, and his coauthors, including fellow Wharton management professors Harbir Singh and Peter Cappelli, as well as Neng Liang from the China Europe International Business School, describe the "China way" of managing. They say business leaders should take note if they want to continue competing with them.

In more than 70 in-person interviews with top Chinese entrepreneurs and executives and accompanying research and analysis, the authors found a handful of themes that describe how and why China has had such great economic success.

One prominent feature among the leaders creating China's great global companies has been their ability to "learn their own way forward," Useem explains. They've taken on the task of creating and running private companies, even though they've been born and raised in the context of an anti-capitalist system.

"They had no business skills, they didn't have anyone who could coach and guide them on how to build an enterprise," he says. "They had to learn how to do it on

their own recurrently, and as a consequence of that, they haven't been burdened by legacy traditions."

Another important aspect of Chinese leaders is that they are extremely agile, Useem says.

"They are willing to move without much notice into a new field, area, or market, not without trepidation, but feeling confident," he says. "They can turn on a dime—or a yuan."

Chinese business leaders also place preference on growth. They focus a lot of attention on expanding current markets and finding new ones and believe profitability is an end product of growing the business, rather than the primary goal.

The authors critique certain aspects of the "China way" that are likely to need pivoting, for instance, their lack of talent management or their "big boss" ideal, but Useem speculates that in 10 or 15 years, "these Chinese companies will overcome those shortcomings.

"In the years ahead, I'm sure we'll see some convergence, with Chinese and Western business leaders picking up wiser practices of the other," he says.

What Helps — and What Doesn't — When Faced with Adversity

In May 2015, Sheryl Sandberg went through the unimaginable when her husband, Dave Goldberg, unexpectedly passed away.

The Facebook chief operating officer and "Lean In" author thought first of her two young children. She confided to her friend Adam Grant, a Wharton psychologist, that her greatest fear was her kids would never be happy again.

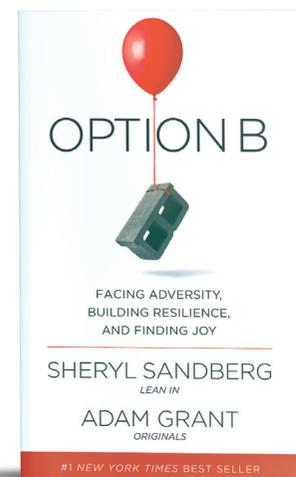
Grant, knowing it would help, talked Sandberg through the data. He explained that, in fact, after losing a parent, many children are surprisingly resilient.

He then began to talk to Sandberg about the importance, too, of her own recovery.

"She said, 'No, no, no, this is not about me,'" Grant recalls. "But I told her, 'If you don't recover, it's going to be harder for your kids to recover.'"

Sandberg learned a lot from Grant's expertise in psychology and also about what people facing adversity go through. Her personal experience gave her a glimpse into what helps, and what doesn't, when it comes to supporting others during tough times.

With hopes of sharing all she learned, Sandberg teamed up with Grant to coauthor "Option B: Facing Adversity, Building Resilience, and Finding Joy," which was published in April 2017. As opposed to merely a "self-help book," they want it to be a "help-others book," Grant says.



Intertwining Sandberg's very personal story with data and research as well as other people's traumatic experiences, they highlight specific ways to be there for others, such as showing up even when not asked, being a "button" for friends to press when they're in need, just doing something as opposed to offering, and kicking the so-called elephant out of

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Hatchetfish

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back at the same angle, matching the light coming from behind it and effectively cloaking the fish.

But Penn researchers, led by Sweeney, realized that acting like a mirror would actually make fish more vulnerable in the deep sea: Light would be sent back to the predator, signaling the fish's location.

The researchers discovered that rather than bounce light directly back, hatchetfish scatter it in a diffuse, non-mirror-like pattern that makes them much less visible to predators hunting with light. The research was published in the *Journal of the Royal Society: Interface*.

In addition, the researchers found that when they shined light directly onto the side of the fish, the structures they were studying actually piped the light through the fish's body, funneling it downward through the photophores in its belly like a "beam dump."

In the shallow part of the ocean, hatchetfish may direct some of the sideways sunlight down through their photophores to assist in their counter-illumination. In the deeper part of the ocean, dumping the light downward throws predators off their trail.

Sweeney says one of the themes in her lab is to push physics by reaching a fuller understanding of what nature and evolution can do. By looking at the mechanisms by which biological materials control light, scientists may be inspired to use similar designs in technological applications.

Federal Funding

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research labs touch about 70 percent of its undergraduates.

"I have three freshmen right now working in my lab," he says. "Penn attracts top students and offers a rigorous education on the best campus in the world. And students have the opportunity to interact with our research faculty in their labs. It's such an important byproduct of federal funding."

Although federal funding for all research institutions has been flat the past 10 years, it hasn't altered Penn's reach.

"It's a function of the fact that we are unique," says Fluharty. "We fare well because we have 12 schools on a single campus in which collaboration is the rule, not the exception. The reality is that even when federal agencies are suffering setbacks, premier institutions like Penn do continue to do well."

But even though Penn holds its market share when it comes to federal funding for research, Bonnell says one of her goals has been to diversify the financial support of the University's research portfolio. As a result, Penn has already seen its industry support for research double in the past five years.

Penn has also increased its efforts to support the next phase of growth around innovation, commercialization, and entrepreneurship, giving rise to what is now the Penn Center for Innovation, attracting even more industry partners.

It's all this and more that forms an evolving epicenter for research at Penn, a University that will continue to thrive by advancing knowledge to serve society, attracting and pushing out fresh talent, sparking innovation, starting new companies, and creating jobs for the city, country, and world.

At the heart of Penn's research enterprise is its community, says Bonnell, "the high-quality students and faculty who have been coming here for a couple hundred years.

"You start with that base and invest in it, and that's how Penn defines the research frontiers we see today," she says. "And that's what the very best researchers want, to be pushing right at the edge."

The Politics of Talking about Race

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looked at the effect that the statements had on a policy's success.

"I literally tracked every single discussion, every State of the Union address, every television interview that the president put forth, and every single statement that Congressional leaders put forth on the House floor," he says.

He found that when presidents speak about racial and ethnic minority concerns and couple these discussions with other issues such as health, they're able to make minorities more conscious of their well-being. If the president talks about race and health, Gillion says minorities are more likely to pay attention to health, and it's more likely to change their opinion on health, alter their behavior, and increase the subject awareness in the minority community.

"Congressional leaders who speak more about racial and ethnic minority concerns actually have more co-sponsors on their bills, and their bills are more likely to pass," he says.

He concludes by advocating that discussions of race in government should not be feared but rather used to learn from one another, address inequality, and improve democracy.

Faced with Adversity

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the room instead of avoiding painful conversations. They also showcase post-traumatic growth and dive into how people become resilient for others.

"So often, when you realize others are depending on you, you find strength you didn't know you had," Grant says. "Sheryl rebuilds her confidence because of her commitment to her colleagues. Why was she able to find joy? Because she wanted her children to find joy."

In addition to their book, Grant and Sandberg created an online community for people to share their stories at *OptionB.org*.

"It's been remarkable to see some of the stories that have come out already," Grant says. "We see them every day now, with people sharing that they felt they were all alone until they joined the community."

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