SCIENCE FROM A TO NYU TO Z

SO MUCH BRAINSTORMING IS AFOOT THAT IT WAS EASY FOR US TO ATTACH ONE INSPIRING ENDEAVOR TO EACH LETTER OF THE ALPHABET

BY LINDSY VAN GELDER

ILLUSTRATIONS BY NATHANIEL KILCER

Individual scientists may hatch brilliant ideas while lounging under apple trees, but in general, science is a team sport.

We asked experts in 26 science fields to give us a snapshot of what's going on in each at NYU, whether it be a cool or cutting-edge piece of research, an important conference, a theory, or a technological breakthrough that has changed everyone's game. Then we catalogued them from A to Z.

But think of them less as a static alphabet sampler than as an alphabet soup, the ingredients of which often combine in synergistic ways. That's because many of our experts also talked to us about collaboration, not only among colleagues in a lab but across departments, schools, and campuses. Joint projects can happen from the top down because of common interest in a topic, but grad students are also often the catalysts, pursuing research that crosses traditional departmental boundaries.

One "natural marriage" is the School of Medicine with many areas of biology and chemistry, according to Mary K. Cowman, associate dean for bioengineering and professor of biochemistry and bioengineering at the Tandon School of Engineering. "Whether it's cartilage repair, musculoskeletal repair, or drug delivery for chemotherapy, every one of us in bioengineering is looking for direct medical applications of our research," says Cowman, who works particularly closely with Thorsten Kirsch, professor of orthopedic surgery and cell biology at the School of Medicine.

Associate professor of biology Kristin Gunsalus (FAS) says technology is driving the teamwork trend. In her field, "Deep sequencing technology has revolutionized genomics, and that has in turn fostered more collaboration among people who know how to develop algorithms to analyze the data, people who specialize in statistical analysis and interpretation, and people who specialize in applying this technology to specific problems," she says.

Enjoy the soup.

ICON KEY

- THINKING MACHINES
- INNOVATIVE EQUIPMENT
- CELLULAR LEVEL
- TECH SAVVY
- WEATHER WORRIES
- THE MIND
- ADVANCED DRUGS
- MEDICAL PRACTICES
- CORONARY CONCERNS
- GERM WARFARE
- POWERFUL PLANTS
- MIND X BODY
- MOLECULAR MATTERS
- GENETIC GENIUS
- CITY SAVERS
- WATER WOES
- PARTICLE DREAMS
- SUSTAINABLE ENERGY

A

AI (ARTIFICIAL INTELLIGENCE)

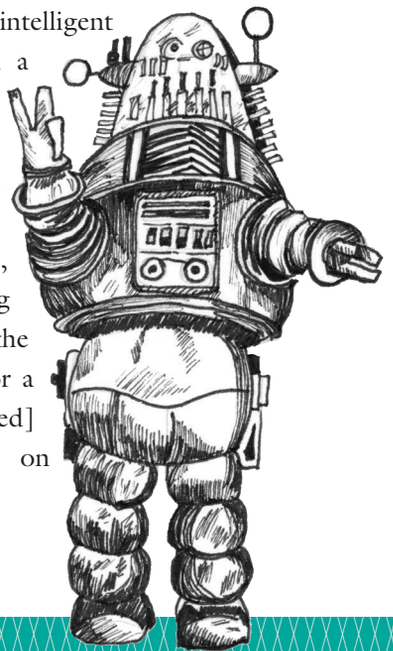
[ahr-tuh-**fish**-uh l • in-**tel**-i-juh ns]

JOAN BRUNA

POSTDOCTORAL RESEARCHER

COURANT INSTITUTE OF MATHEMATICAL SCIENCES

Modern algorithms have helped machines acquire more smarts in the past few years than they gained in the entire previous generation. Bruna notes that the branch of AI he's studying, which focuses on incorporating intelligent vision in devices, is living in a golden age. And "automated driving is one of the main motivations," he adds. The task is to make the computer not just receive and store images, but also understand if the thing that is moving in front of the car is another car, a bicycle, or a pedestrian. "Because it will [need] to act differently depending on what is what," Bruna says.



B

BIOIMAGING

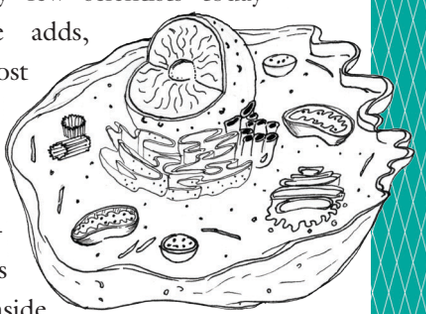
[bahy-oh-**im**-uh-jing]

DAVID FENYO

PROFESSOR OF BIOCHEMISTRY AND MOLECULAR PHARMACOLOGY

SCHOOL OF MEDICINE

Superresolution fluorescence microscopy lets scientists look inside living cells. Thanks to this groundbreaking technology, Fenyo explains, "we can see smaller structures and collect data faster" by a factor of 10 over conventional microscopes. But very few scientists today use these tools, he adds, "because for the most advanced microscopy, you need someone who builds their own instruments." Fenyo—whose research involves the repair process inside cells and looks at how proteins interact at the cellular level in various diseases—has such a master builder: his colleague, assistant professor Eli Rothenberg.



C CYBERSECURITY

[sahy-ber-si-**kyoor**-i-tee]

NASIR MEMON

PROFESSOR OF COMPUTER SCIENCE AND ENGINEERING

TANDON SCHOOL OF ENGINEERING

"When the main user interface was the keyboard, passwords made sense," says Memon. No more, which is why he is working on security that uses hand gestures instead. He has also developed a camera-fingerprinting system to discern if a photograph is real or fake. "Like a bullet in a gun, you can tell what camera a picture is from," he explains, and a doctored photo fingerprint is obvious. His colleagues, meanwhile, have perfected the security of software updates "so the bad guys can't slip in" and fought global spammers by tracing what they sell to their bank accounts.

D DATUM

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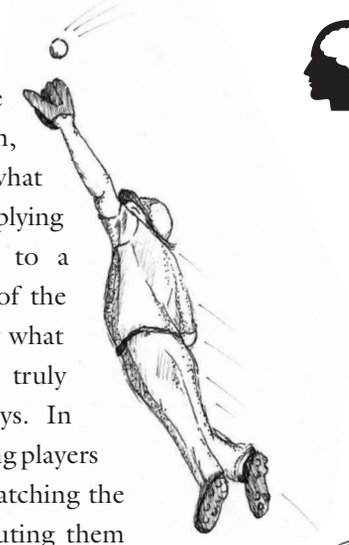
CLAUDIO SILVA

PROFESSOR OF COMPUTER SCIENCE AND ENGINEERING

TANDON SCHOOL OF ENGINEERING



Working with Major League Baseball's technology arm, Claudio Silva is generating what we'll call stats on steroids. By applying machine learning techniques to a database of every single play of the 2015 season, "we can quantify what the players are doing in truly unprecedented detail," he says. In response, teams are repositioning players to maximize their chances of catching the ball rather than evenly distributing them throughout the field. Silva is similarly stoked by the insights yielded from facts collected since 2009 from one billion GPS-tracked taxi trips. "It's an unprecedented view into what's happening in New York City."

E EMERGENCIES

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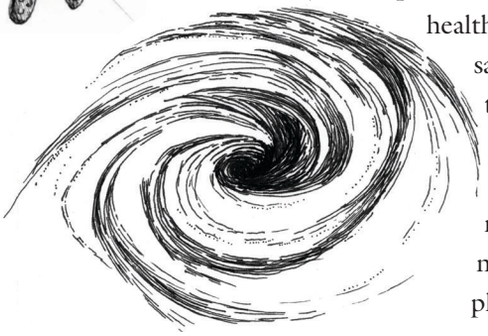
DAVID ABRAMSON

CLINICAL ASSOCIATE PROFESSOR OF GLOBAL PUBLIC HEALTH

COLLEGE OF GLOBAL PUBLIC HEALTH



"There's something universal about a disaster's effect on exposed populations," says Abramson, who has studied the human cost in such disparate emergency situations as hurricanes and tornadoes, an oil spill, and several disease epidemics. His findings indicate that the type of disaster and its severity—whether, for instance, Hurricane Katrina was more devastating in the big picture than Hurricane Sandy—matters little to those whose lives are thrown into chaos. "They end up with the same kinds of mental health issues," Abramson says, including post-traumatic stress, anxiety, depression, grief, and, over time, possible stress-related cardiovascular, neurological, and other physical effects.

F FEAR

[feer]

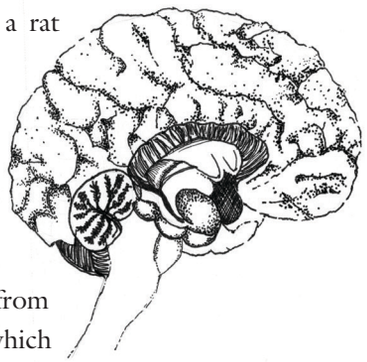
JOSEPH E. LeDOUX

PROFESSOR OF NEURAL SCIENCE AND PSYCHOLOGY

FACULTY OF ARTS AND SCIENCE

SCHOOL OF MEDICINE

The antianxiety drugs taken by millions of Americans might be useless, says LeDoux. That's because they target the amygdala, the part of the brain that controls behaviors commonly associated with stressful situations. Studies at his Washington Place lab show that medications can make a rat threatened by wide-open spaces amble slowly rather than scurry to a corner of a box. LeDoux's contention (expounded on in his book *Anxious*) is that these circuits are completely different from those that produce fear, which may (or may not) accompany danger. Like the lab rat, a person can be made less reluctant to face a scary social situation, he says, "but still feel like crap at the party."



G GENOMICS

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KRISTIN GUNSALUS

ASSOCIATE PROFESSOR OF BIOLOGY

FACULTY OF ARTS AND SCIENCE

Many anticancer drugs, as well as the first anti-HIV drug, came from marine organisms. Gunsalus's team is exploring bacteria in the tide pools and mangrove creeks of Abu Dhabi in search of molecules with therapeutic potential against diseases like cancer or parasitic infections. Their approach—chemical genomics—involves the systematic screening of how chemicals interact with cells. "This is a region with a very unusual ecology that no one has sampled before," Gunsalus says, "and it's teeming with life." One of their first samplings found a molecule known to cause cell death in human prostate cancer.

H HEALTHCARE

[**helth**-kair]

GBENGA OGEDEGBE

VICE DEAN / PROFESSOR OF POPULATION HEALTH AND MEDICINE

COLLEGE OF GLOBAL PUBLIC HEALTH / SCHOOL OF MEDICINE

Getting people to adopt a healthy lifestyle is half the battle in many chronic diseases. Rather than focusing on traditional venues as the point for managing hypertension, Ogedegbe's team trained lay advisers at 32 African American churches in New York City to do blood pressure readings and to counsel patients about self-care. Scriptural passages and concepts like the notion that one's body is a temple of God were also incorporated. The results: an average six-to-nine-point drop in patients' systolic pressures. "The churches are places that they trust, and the intervention was by people they trust," Ogedegbe says.

I INFECTIVITY

[in-fek-**tiv**-i-tee]

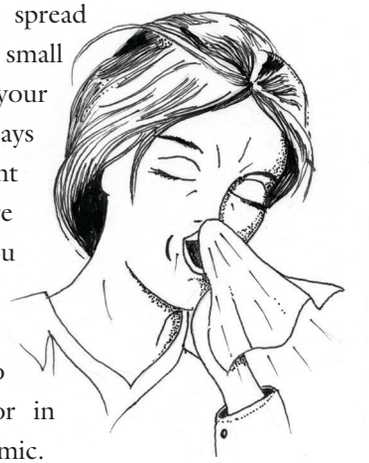
ELODIE GHEDIN

PROFESSOR OF BIOLOGY AND PUBLIC HEALTH

FACULTY OF ARTS AND SCIENCE

COLLEGE OF GLOBAL PUBLIC HEALTH

There are 10,000 strains of influenza, and their superpowers include jumping across species, lying dormant in freezers for decades, and piggybacking on dominant strains. Any flu infection is a combination of strains, although vaccines typically target only the dominant component. Ghedin's team discovered that these lesser strains help spread the virus. Even if only a small percent of the virus in your nose is a minor strain, says Ghedin, "I can now paint a picture of what you are actually carrying when you sneeze on me." The information will help track "who transmits to whom in households or in schools" during an epidemic.



J JUDGMENT

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MARJORIE RHODES

ASSOCIATE PROFESSOR OF PSYCHOLOGY

FACULTY OF ARTS AND SCIENCE

Researchers have known for some time that children judge an action on how much harm it does. Rhodes has discovered that kids also calibrate the degree of their judgments based on whether they think the person doing the harm is in the same group as the other person. Presented with hypothetical interactions between two groups called the Flurps and the Zazzes, young children were told that there were no rules against various acts—from stealing a cookie to not letting someone play—that they found harmful. "But children as young as 3 nonetheless still felt an obligation not to harm members of one's own group," says Rhodes.

K KINESIOLOGY

[ki-nee-see-**ol**-uh-jee]

MARILYN MOFFAT

PROFESSOR OF PHYSICAL THERAPY

STEINHARDT SCHOOL OF CULTURE, EDUCATION, AND HUMAN DEVELOPMENT

"Kinesiology is the scientific study of human movement," Moffat (STEINHARDT '64, '73) explains. "It involves the application of the sciences of biomechanics, anatomy, physiology, psychology, and neuroscience." Moffat's team's current research includes a study of how important visual cues are to balance and another that will test how to predict which patients will have successful lower back surgery. A recent collaboration with the Division of Hand Surgery at the Department of Orthopaedic Surgery looked into the mechanics of yoga poses and found that yoga participants were able to achieve the proper alignment only about 25 percent of the time.

L LONGEVITY

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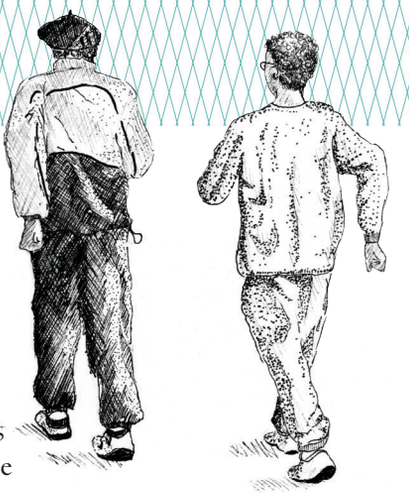


ABRAHAM BRODY

ASSISTANT PROFESSOR

RORY MEYERS COLLEGE OF NURSING

"Live long and prosper" would be an apt mission statement for NYU's new Aging Initiative, a university-wide endeavor focused on age-sensitive care launched in the fall of 2015. Uniting experts from disparate fields (ancient history, engineering, occupational therapy, social demography, technology), the project is spearheaded by the medicine and nursing schools; much of the research is being tested at the latter's Hartford Institute for Geriatric Nursing. According to Brody (CAS '02), the institute's associate director, the goals are "to look at aging through a much larger lens" and to keep older adults healthy and independent so they can lead longer, higher-quality lives.

M MODELS

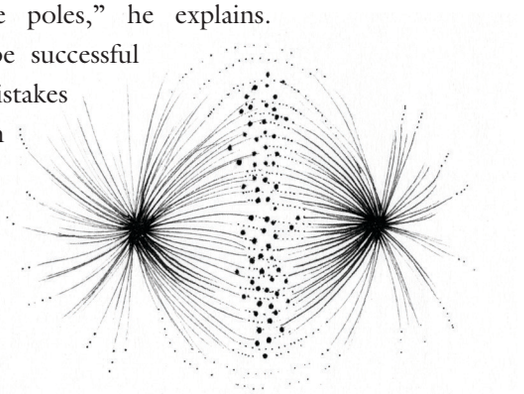
[**mod**-l s]

ALEX MOGILNER

PROFESSOR OF MATHEMATICS AND BIOLOGY

COURANT INSTUTUTE OF MATHEMATICAL SCIENCES

Computer modeling is used in everything from economics to the natural sciences. Mogilner develops models with cell biologists studying mitosis, especially the structure known as the mitotic spindle, where chromosomes are segregated to the poles of a cell before it divides. "A really fascinating and totally unexpected finding has been that it turns out that cells make very few mistakes connecting chromosomes to the poles," he explains. The next step will be successful modeling of how mistakes do happen—which has implications both for fetal development and cancer research.



N NEUROECONOMICS

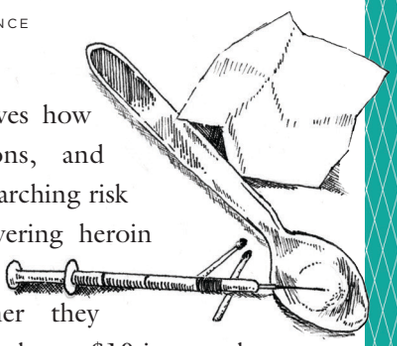
[noo r-oh-ek-uh-**nom**-iks]

PAUL GLIMCHER

PROFESSOR OF NEURAL SCIENCE, ECONOMICS, AND PSYCHOLOGY

FACULTY OF ARTS AND SCIENCE

NYU SHANGHAI



Neuroeconomics involves how people make decisions, and Glimcher has been researching risk tolerance among recovering heroin addicts. Asking people questions like whether they would rather have $5 today or $10 in a week, Glimcher's team coordinates those responses with the incidence of drug relapses. It looks as though "what happens is that they relapse when they become transiently more risk-taking," he says; thus counselors who work with recovering addicts should focus less on normal impulsiveness and more on "when you are feeling like you could take a chance." A smartphone app accessed daily could monitor such feelings and trigger an intervention.

OCEANOGRAPHY

[oh-shuh-**nog**-ruh-fee]

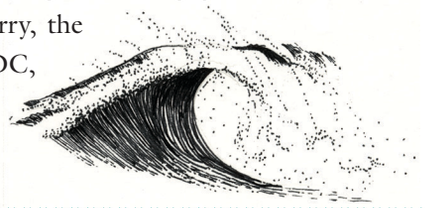
DAVID HOLLAND

PROFESSOR OF MATHEMATICS AND ATMOSPHERE-OCEAN SCIENCE

COURANT INSTITUTE OF MATHEMATICAL SCIENCES

NYU ABU DHABI

NYU has more than an academic interest in the effects of climate change, since all three of its degree-granting campuses are in low-lying coastal cities vulnerable to rising sea levels. Holland—and his project coordinator and wife, Denise Holland—held a symposium in Abu Dhabi this past spring that highlighted modeling of melting glaciers and ocean simulations. Then in summer, at the invitation of Secretary of State John Kerry, the Hollands participated in the State Department's Our Ocean conference in Washington, DC, which focused on such issues as sustainable fishing and safe havens for marine animals.



PLASTICITY

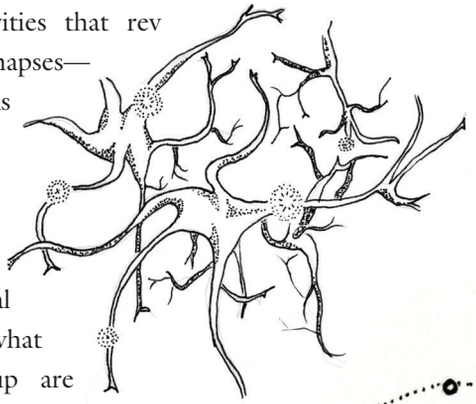
[pla-**stis**-i-tee]

DAN SANES

PROFESSOR OF NEURAL SCIENCE AND BIOLOGY

FACULTY OF ARTS AND SCIENCE

The changes in the nervous system known as plasticity are usually thought of in terms of learning activities that rev up and strengthen synapses—the process known as excitatory connection. Sanes's group found something that at first seems counterintuitive: At the moment an animal learns an auditory task, what actually gets revved up are a group of inhibitory synapses whose job is normally to suppress activity. Sanes posits that the suppression is important because otherwise "the nervous system would be overwhelmed and could not process information. It's like why you have brakes on your car."



QUANTA

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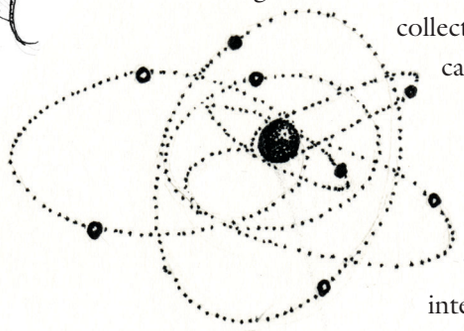
ZLATKO BAČIĆ

PROFESSOR OF CHEMISTRY

FACULTY OF ARTS AND SCIENCE

Bačić may deal with the tiny in his study of quantum mechanics, but the probable impact of his work is huge. Fueled by a half-million-dollar National Science Foundation grant, he and his colleagues have experimented with putting a single water molecule into each of the C60 molecules ("buckyballs") that make up a crystal. "What is nice about water molecules," Bačić says, "is that they are really charged. Charges interact. Which means they exhibit collective behavior and you can start manipulating them." The result is the potential to create material with compelling properties. "It opens up very interesting possibilities in what is called nanoelectronics," Bačić says.



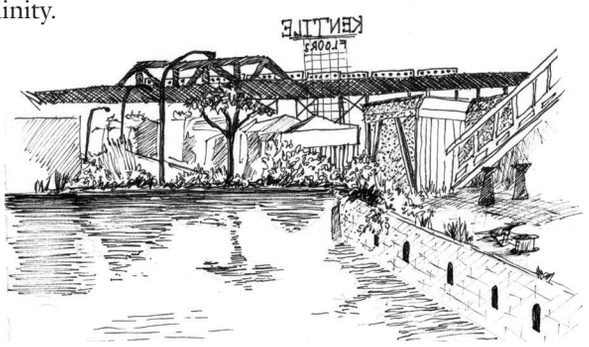
R ROBOTICS

[roh-**bot**-iks]

MAURIZIO PORFIRI

PROFESSOR OF MECHANICAL AND AEROSPACE ENGINEERING
TANDON SCHOOL OF ENGINEERING

Porfiri's "bio-inspired" robots in various sizes, shapes, colorations, and other physical variations are tested to see how to make schools of fish follow them. Does size matter? Yes. So do hydrodynamics: Even if the robot is unfamiliar looking, if it swims in such a way that it creates a wake, real fish will tag along behind. In the event of an oil spill, Porfiri explains, "we may want to use them as sheepdogs to herd fish away" and into safer water. Some of the robots are currently in the Gowanus Canal monitoring salinity.



S SIGNALS

[**sig**-nl s]

MOSES CHAO

PROFESSOR OF PSYCHIATRY; CELL BIOLOGY, NEUROSCIENCE, AND PHYSIOLOGY
SCHOOL OF MEDICINE

"The whole point in our work is to find fundamental mechanisms that promote health," Chao says. His team has been looking at neurotrophic factors, a family of proteins that are used by neurons in the brain to signal to each other and that have strong links to functions like memory and learning. Although signaling dysfunction seems to play a part in Alzheimer's disease, "it's very hard to deliver this protein to the brain" by pharmaceutical means, Chao explains. His team is looking at an alternative form of delivery. By studying mice on treadmills, "we are trying to understand how physical exercise provides signals to brain cells," he says.

T TISSUES

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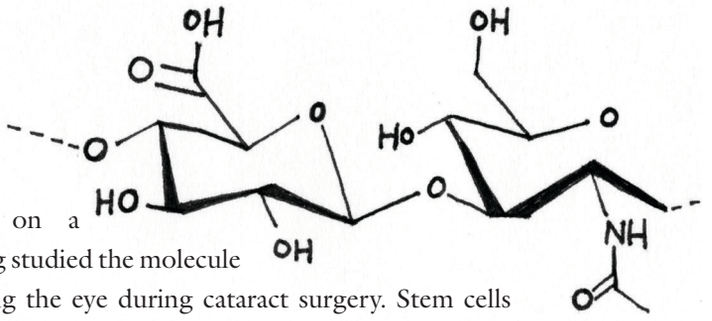
MARY K. COWMAN

ASSOCIATE DEAN FOR BIOENGINEERING
TANDON SCHOOL OF ENGINEERING



Cowman's team has a pending international patent on a formulation that can be used to heal cartilage. Cowman has long studied the molecule hyaluronan, which already has such medical uses as protecting the eye during cataract surgery. Stem cells also hold huge regenerative promise. Her group combined hyaluronan with a peptide that controls how the hyaluronan affects cells, "and the double hit of those two together has caused stem cells to fix cartilage damage.... At the moment we've only tested it for traumatic damage, like car accidents," Cowman says, but testing on whether it can repair osteoarthritis is under way.

U URBANITY

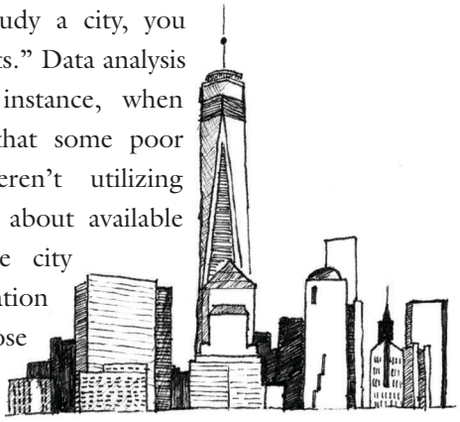
[ur-**ban**-i-tee]

STEVEN KOONIN

DIRECTOR

CENTER FOR URBAN SCIENCE AND PROGRESS

"Cities are the most complicated mechanisms humanity has invented," says Koonin. "Our center has an economist, a civil engineer, a professor of music [who helps monitor noise pollution], an astronomer [who looks at soot plumes on the horizon to gauge heating-oil pollution], a traffic engineer, an environmental scientist, a computer scientist, and a physicist. If you want to study a city, you need all these talents." Data analysis looms large; for instance, when students realized that some poor neighborhoods weren't utilizing a website to learn about available social services, the city used the information to advertise in those neighborhoods.



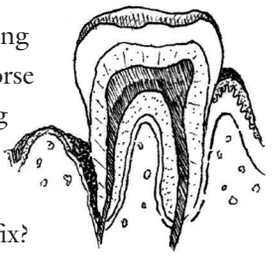
V VESTIBULOPLASTY

[ve-**stib**-yel-oh-plas-tee]

ROBERT GLICKMAN

CHAIR AND PROFESSOR OF ORAL AND MAXILLOFACIAL SURGERY

COLLEGE OF DENTISTRY



It's a common nightmare: losing one's teeth. What makes it worse in real life is that the underlying bones and gums can shrink to where they no longer support a denture or implant. The fix? Vestibuloplasty, a procedure in which an incision is made that better positions the muscle and soft tissue so the area can be restored. For decades surgeons have grafted tissue from, say, the thigh of the patient to cover the wound. But now Glickman is among a small group of trailblazers who instead are using amniotic/chorionic membranes derived from the placentas of consenting moms. "They have growth factors that promote quicker, more pain-free healing," Glickman says, "and you don't need a donor site [for a graft]."

W WIRELESSNESS

[**wahyuh r**-lis-nis]

SUNDEEP RANGAN

ASSOCIATE PROFESSOR OF ELECTRICAL AND COMPUTER ENGINEERING

TANDON SCHOOL OF ENGINEERING

Cell phone networks are getting as congested as the rush hour subway. The NYU Wireless group is part of an effort to bring a new bandwidth utilizing the millimeter wave spectrum to the 5G devices of the future. "There are two big technical challenges," Rangan, director of the group, explains. One is that signals are blocked by building materials like mortar, brick, and coated glass; the other is that beams are so narrow that transmission gets tricky "if you're walking around or in your car." Rangan's Tandon colleagues are researching ways around these challenges; group members from the medical school, meanwhile, are exploring health and safety issues.

X-RAYS

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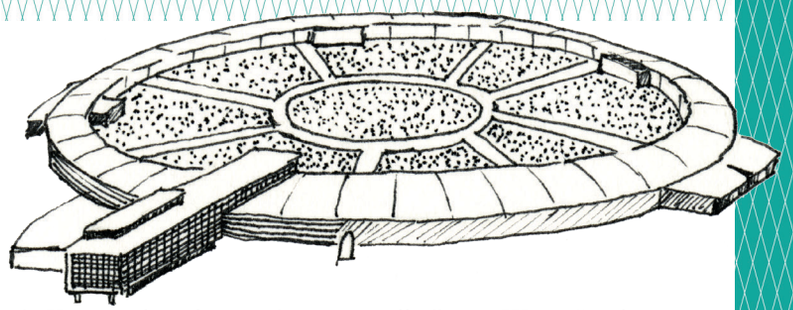


L. ANDREW WRAY

ASSISTANT PROFESSOR OF PHYSICS

FACULTY OF ARTS AND SCIENCE

The big new thing in X-ray is the Department of Energy's massive National Synchrotron Light Source II facility in Brookhaven, New York. Its image capabilities "are to a dentist's X-rays what the sun is to a candle," says Wray, "and unlike a dental X-ray, you get a 3-D image that tells you not just what the structure of something is, like where the bones are, but the composition. Like if you X-ray a spider's fang it will show you the chemical composition of the toxins in the fang." As a local institution, NYU will have an especially close collaborative relationship with the facility.

YEAST

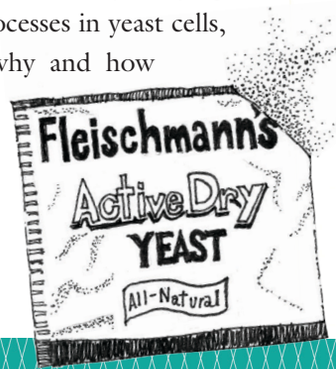
[**yeest**]

DAVID GRESHAM

ASSOCIATE PROFESSOR OF BIOLOGY

FACULTY OF ARTS AND SCIENCE

"Everything that is true for yeast cells is true for human cells," which makes them an almost perfect biological model, says Gresham. (And unlike rats, they reproduce quickly—in an hour and a half versus three weeks; they also don't involve cruelty to lab animals; and they even smell delicious.) Biologists at NYU are currently using yeast cells to study a number of processes, from genome replication to how cells evolve when they are under pressure. "By studying these basic cellular processes in yeast cells, we can understand why and how they have gone wrong in cancer cells," Gresham explains.



ZE (ZERO ENERGY)

[**zeer**-oh • **en**-er-jee]

PAT SAPINSLEY

MANAGING DIRECTOR OF CLEANTECH INITIATIVES

TANDON SCHOOL OF ENGINEERING

Sapinsley's program provides about 20 green startups with one intern a semester, coming from Stern, Tandon, Wagner, Gallatin, and elsewhere across NYU. Another of her programs trains executives who want to switch to clean-energy careers and incubates start-ups. One of the big successes this year was United Wind, whose owner, Sapinsley says, "was doing wind data analytics and noticed that solar companies that were doing leases were surging ahead, because there were no upfront costs. No one was doing wind leases on farms." The company's owner offered to install wind power on upstate farms, got a loan of $4 million, and within months had $213 million in investor loan commitments.