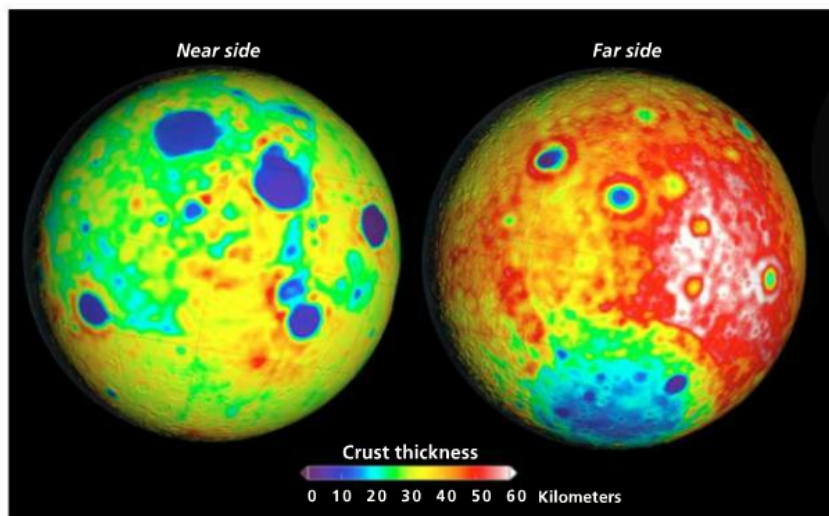


# Beneath the Moon's Two Faces

➔ Astronomers have finally figured out why the moon is so two-faced, and it turns out the answer was with us all along: It's Earth's fault.

The moon's two faces look nothing alike. The far side has significantly fewer of the familiar dark patches, formed by ancient lava flows. That's because the lunar crust is thicker there, making it harder for asteroid impacts to break through and release magma. But why was the crust thicker to begin with?

A team of Pennsylvania State University astronomers came up with a likely answer last summer, one that dates back to the moon's formation. When a Mars-size body collided with the young Earth some 4.5 billion years ago, the material that shot into orbit eventually coalesced and cooled into the solid moon, with one side always



Earthly heat may be to blame for the thicker crust on the moon's far side.

facing Earth. But the crash also heated our planet to over 7,000 degrees Celsius (13,000 degrees Fahrenheit), energy that irradiated the moon's near side, keeping it molten much longer.

The far side, on the other hand, cooled sooner, making conditions more favorable for material to condense

there. That material became lunar rock, resulting in a thicker crust on that hemisphere.

A similar process can probably occur on extrasolar planets that are heated to lopsidedness by their host stars, so at least the moon isn't the only one with two faces. —KATHERINE KORNEI

## 2014 World Debut: New Species Series



Call for Help

### 2014 World Debut: New Species Series

#### *Boophis ankarafensis*

**Type of animal:** Tree frog

**Description:** Bright green; reddish-brown speckles on head and back

**Home:** Ankarafa Forest in northwest Madagascar

**Fun fact:** *B. ankarafensis* has a notable calling card: Instead of producing three clicks to attract a mate, the new species uses only two. This missing click got researchers' attention just in time. Although the froggies reside within the protected Sahamalaza-Îles Radama National Park, ongoing destruction of their habitat threatens their numbers, leading researchers to suggest a placement on the critically endangered list. Heeding their call could help save the species. —BRENDA POPPY

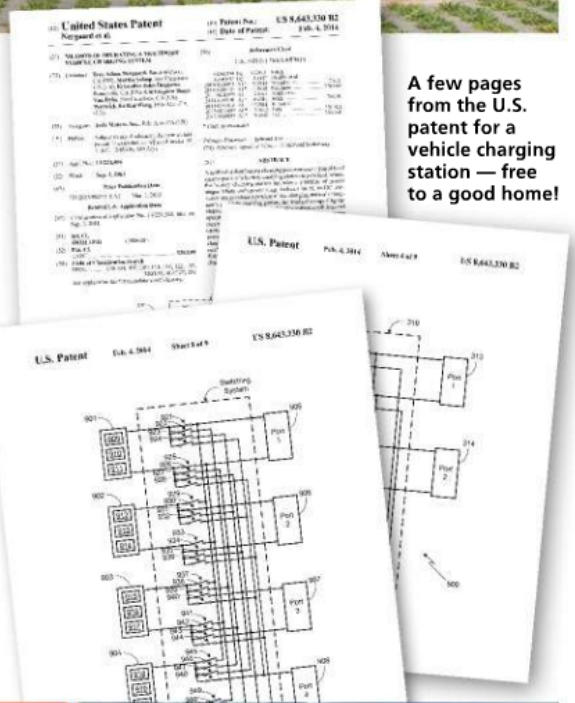




Tesla electric cars "fill up" at a fast-charging station in Hawthorne, Calif.

## Tesla's Perplexing Patent Giveaway

→ Patents are the prizes of modern innovators, talismans of technological prowess, potential tickets to profits and power. So it came as a shock in June when Tesla Motors CEO Elon Musk released all the company's electric-car patents. Musk said he shared his patents for parts and processes merely to jump-start the slow-selling electric vehicle market, but some analysts and tech commentators weren't buying it. They saw Musk's move as a play to make Tesla's technologies — especially its charging stations — an industry standard. Many advocates hoped the release would mark the beginning of an end to brutal, litigious patent wars that stultify innovation. —MICHAEL FITZGERALD



A few pages from the U.S. patent for a vehicle charging station — free to a good home!



Before



After

Tesla CEO Elon Musk referenced a popular Internet meme when he titled the announcement, "All Our Patent Are Belong to You," a joke that carried through to the decor at Tesla headquarters in Palo Alto, Calif., where a giant poster replaced a wall of patents.



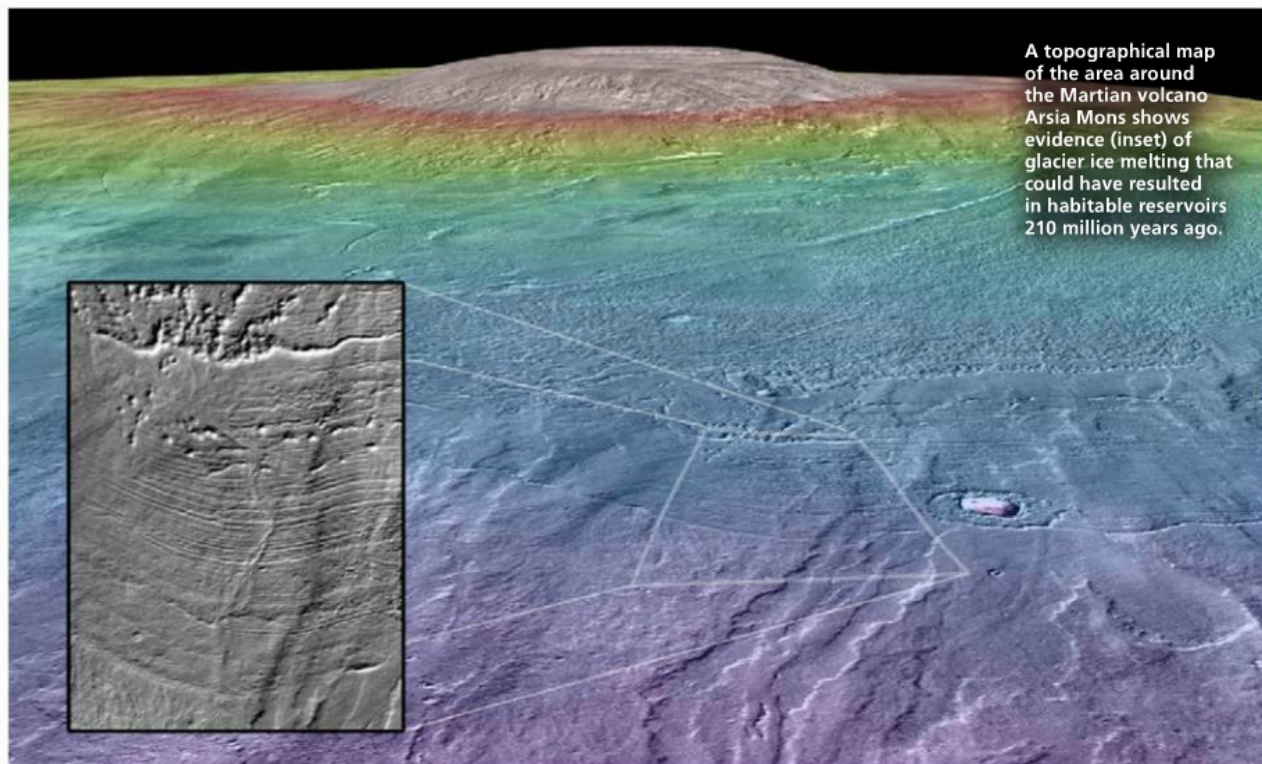
# The Living Lakes of Mars' Recent Past

→ If life ever thrived on Mars (still a big if), it could've done so much more recently than scientists thought. In May, Brown University's Kat Scanlon presented geologic evidence that one of the solar system's largest volcanoes, the Red Planet's Arsia Mons, melted glaciers that were creeping across its surface some 210 million years ago, creating large oases for possible Martian microbes.

As the volcano vented lava beneath the thick ice sheets, it released huge quantities of liquid water within

the glacier. Two reservoirs were each big enough to fill Utah's Great Salt Lake twice over.

The finding serves as tantalizing evidence that life-friendly environments existed on Mars much more recently than at the sites explored by NASA's rovers; those sites date back more than 2.5 billion years. Scanlon calculates that the water survived entombed in the ice for hundreds or even thousands of years — not long enough for new life to evolve, but certainly enough to form a habitat for any dormant microbes. —ERIC BETZ



A topographical map of the area around the Martian volcano Arsia Mons shows evidence (inset) of glacier ice melting that could have resulted in habitable reservoirs 210 million years ago.

# Conception Code Cracked

→ Sperm meets egg: This rendezvous is crucial to procreation. But the actual mechanism behind fertilization has remained a mystery — until now.

British scientists published a study in April that identified a protein on the egg's surface — dubbed Juno, after the Roman goddess of fertility — that fuses with its male counterpart on the sperm cell, resulting in conception.

Using an artificial version of the

protein Izumo, found on the surface of sperm, the team scoured the genetic sequences of millions of proteins until they found one that attached itself to Izumo, like a key in a lock. But the attraction between Juno and Izumo is weak, which explains why it took so long to ferret out the protein. Once fertilization occurs, the Juno protein virtually disappears from the egg's surface in about 40 minutes, ultimately preventing other sperm from entering.

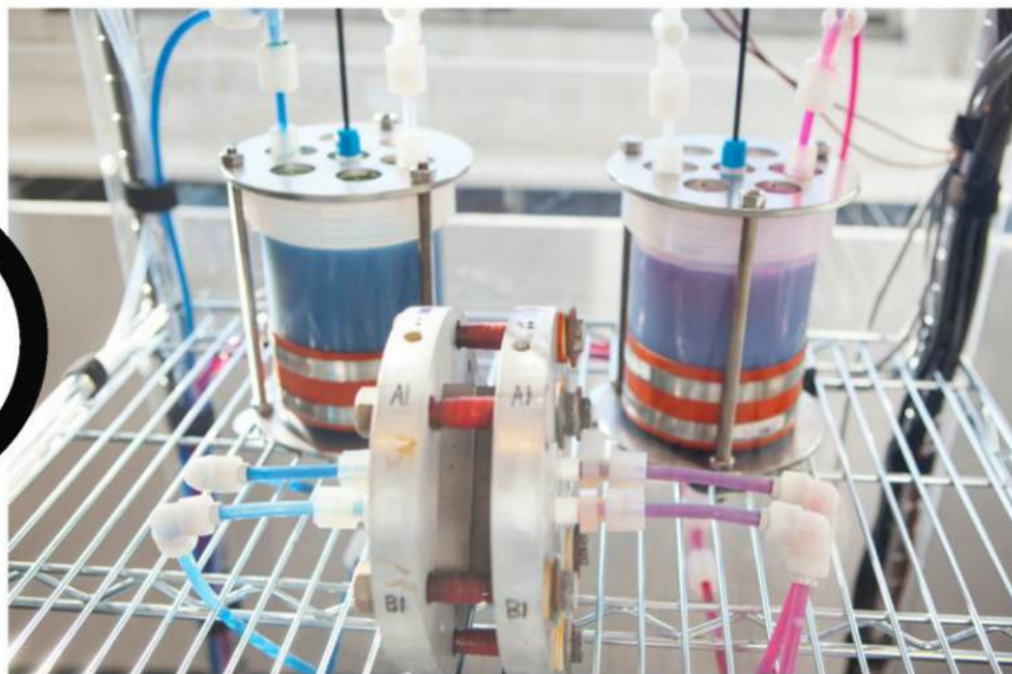


A specific protein is key to egg fertilization.

The discovery could result in a genetic test to detect if a woman's infertility is due to a defective Juno protein. It also may lead to contraception that blocks the action of these proteins, thwarting sperm. —LINDA MARSA

# Bio-Inspired Battery Could Help Green the Grid

63



A prototype metal-free flow battery developed by engineer Michael Aziz (bottom) and colleagues at Harvard University relies on the electrochemistry of naturally abundant, small organic molecules to store electricity generated from renewable, intermittent energy sources.

➔ The biggest hurdle to getting more electricity from renewable energy sources is the intermittency of the sun and wind — a problem that better batteries with less expensive materials could solve by storing large amounts of energy until needed. Now scientists think they may have the solution, with the help of a little organic chemistry.

Like conventional batteries, flow batteries store chemical energy and have a positive and negative electrode. When the battery is discharged, electrons and ions move from one electrode to the other, generating a current. Conventional battery materials are solid, while a flow battery's chemicals — often expensive because they're from rare metals — are liquid. To hold a large amount of energy, flow batteries need tanks capable of storing thousands of gallons of liquid. "If you want more energy, you just make bigger storage tanks," says Michael Aziz, an engineer at Harvard. "But the chemicals have to be cheap."

So Aziz, along with colleagues in the chemistry department, looked to nature for a more practical solution. They turned to quinones, a carbon-based class of chemicals that play an important role in animal and plant metabolism, moving electrons in the chemical reactions we use to store energy in our bodies. The

researchers suspected that quinones also could move electrons in flow batteries. The quinone they picked, called AQDS, is already used in petroleum processing.

In January 2014, in the journal *Nature*, the researchers described a prototype flow battery that uses AQDS for one electrode. They showed that not only does it hold more energy than a conventional flow battery, but the cost of the quinone battery is much lower than other flow batteries — less than \$27 per kilowatt-hour of energy stored, compared with \$81. They're now working with a Connecticut company to develop a prototype system. — KATHERINE BOURZAC



Aziz's prototype would cost much less than other flow batteries.





## Quicker Quantum Boot-Up

→ Quantum computers — machines that make use of the strange properties of the subatomic realm — will be versatile and powerful, scientists hope, but today's versions take a painstaking six hours to boot up. Fortunately, in June, physicists at Germany's Saarland University reported in *Physical Review Letters* that they had devised a way to boot up experimental quantum chips within minutes, almost as quickly as a desktop computer.

Booting up took so long because quantum computer chips are extremely sensitive to changes in temperature, air pressure and electromagnetic interference, and each day researchers had to spend hours tuning the chips by hand. The trick was to come up with an algorithm that can systematically tune a quantum chip in just five minutes. The method should work for tomorrow's quantum computers, but for now, the algorithm, called Ad-HOC, will speed research by giving physicists more time to explore the nascent technology. —SHANNON PALUS

### FROM QUBITS TO GADGETS

A new type of laser created by Dartmouth physicists could one day translate the photon-speak of quantum chips into signals that other gadgets — say, a computer screen — can understand. The laser's circuitry is made of the same superconducting material used in many quantum chips. This allows the quantum information to be encoded as particles of light, which could send a signal to another device. —SP



## Can Vitamin D Prevent Alzheimer's Disease?

→ In August, researchers announced they had found a strong connection between low vitamin D levels and dementia, a deterioration of mental faculties affecting roughly 5.2 million Americans.

In the 1990s, U.S. researchers took blood samples from 1,658 participants age 65 or older as part of a cardiovascular study. About six years later, they followed up to see who had developed health complications, including symptoms of dementia and Alzheimer's disease, its most common form. Later, other U.S. scientists studying nutrition tested the original samples' vitamin D levels.

In the new study, a group of British researchers built upon both of those findings to determine whether there was an actual link between vitamin D levels and dementia. Their statistical analysis of the U.S. data connected insufficient vitamin D levels to a 53 percent increased risk of dementia and a 69 percent increased risk of Alzheimer's. The study, the largest of its kind, found that severe vitamin D deficiencies more than doubled the odds of developing Alzheimer's, a more substantial risk than previous studies had found.

These shortages might be because older skin converts sunlight into vitamin D less efficiently than younger skin. But experts aren't yet ready to recommend that older people load up on the sunshine vitamin: Researchers still need to determine whether higher vitamin D levels actually prevent the disease. —LINDA MARSA



## Facebook Experiments on Users, Faces Blowback

➔ People don't often get riled up about research, but when Facebook toyed with its members' emotions without telling them, it stirred up plenty of feelings offline as well.

In June, researchers revealed in the *Proceedings of the National Academy of Sciences* that they had manipulated news feeds of unsuspecting Facebook users, influencing whether they felt positive or negative emotions. News of the experiment angered scores of users and privacy advocates. Before long, the journal backpedaled from its decision to publish the study with an "Editorial Expression of Concern," admitting that participants may not have known they were guinea pigs and did not get the chance to opt out.

The experiment, conducted over one week in January 2012, looked at "emotional contagion" — whether user emotions would affect other users' emotions online, as they do in person. Facebook used an algorithm to weed out posts with positive or negative words in the news feeds of 690,000 of its 1.3 billion users. Users who saw positive posts were more likely to post positive things than users who saw negative posts.

Privacy advocates demanded that the Federal Trade

Commission investigate Facebook's research practices since it had experimented on human subjects without their permission. The FTC, per its policy, declined to comment on whether they were looking into it. But before the kerfuffle, Facebook quietly changed its data use policy to allow research on people — four months after finishing the experiment.

A university institutional review board probably would have signed off on Facebook's experiment, says Harvard Business School's Michael Luca, who has received approval to conduct similar covert experiments with other companies' websites. That's because informed consent is not needed for research that subtly manipulates people without overtly lying to them and causes only minor harm, he says.

Months after the news broke, Facebook said it would step up training for its scientists and have its senior researchers scrutinize proposed studies on content "that may be considered deeply personal," according to a blog post by Mike Schroepfer, Facebook's chief technology officer. "We were unprepared for the reaction the paper received when it was published and have taken to heart the comments and criticism." —MICHAEL FITZGERALD



**NEW**

“My friends all hate their cell phones... I love mine!”  
Here’s why.

Better  
Sound and  
Longer Battery Life

No  
Contract

FREE  
Car  
Charger

Say good-bye to everything you hate about cell phones. Say hello to Jitterbug.

“Cell phones have gotten so small, I can barely dial mine.” Not Jitterbug®, it features a larger keypad for easier dialing. It even has an oversized display so you can actually see it.

“I had to get my son to program it.” Your Jitterbug set-up process is simple. We’ll even pre-program it with your favorite numbers.

“I tried my sister’s cell phone... I couldn’t hear it.” Jitterbug is designed with an improved speaker. There’s an adjustable volume control, and Jitterbug is hearing-aid compatible.

“I don’t need stock quotes, Internet sites or games on my phone, I just want to talk with my family and friends.” Life is complicated enough... Jitterbug is simple.

“What if I don’t remember a number?” Friendly, helpful Jitterbug operators are available 24 hours a day and will even greet you by name when you call.

“I’d like a cell phone to use in an emergency, but I don’t want a high monthly bill.” Jitterbug has a plan to fit your needs... and your budget.

“My cell phone company wants to lock me in on a two-year contract!” Not Jitterbug, there’s no contract to sign and no penalty if you discontinue your service.



	Basic 14	Basic 19
Monthly Minutes	50	was 100 NOW 200
Monthly Rate	\$14.99	\$19.99
Operator Assistance	24/7	24/7
911 Access	FREE	FREE
Long Distance Calls	No add'l charge	No add'l charge
Voice Dial	FREE	FREE
Nationwide Coverage	YES	YES
Friendly Return Policy <sup>1</sup>	30 days	30 days

More minute plans available. Ask your Jitterbug expert for details.

“I’ll be paying for minutes I’ll never use!”

Not with Jitterbug, unused minutes carry over to the next month, there’s no roaming fee and no additional charge for long distance.

“My phone’s battery only lasts a couple of days.” The Jitterbug’s battery lasts for up to 25 days on standby.

Enough talk. Isn’t it time you found out more about the cell phone that’s changing all the rules? Call now, Jitterbug product experts are standing by.

Available in Blue, Red (shown) and White.

Order now and receive a  
**FREE Car Charger** for your Jitterbug –  
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Call toll free today to get your own Jitterbug5.

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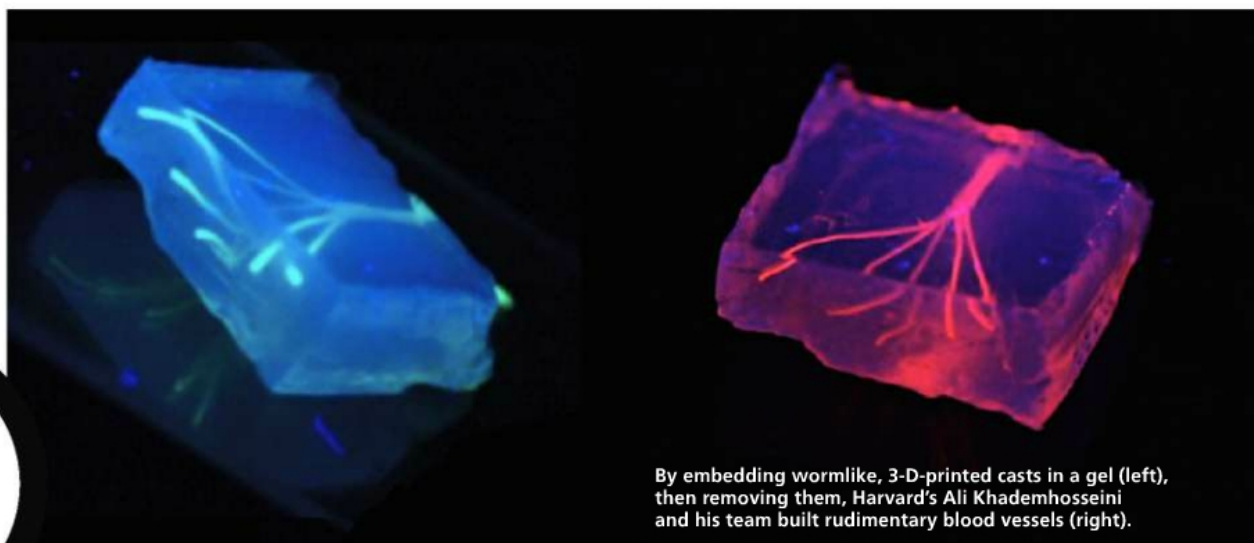
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By embedding wormlike, 3-D-printed casts in a gel (left), then removing them, Harvard's Ali Khademhosseini and his team built rudimentary blood vessels (right).

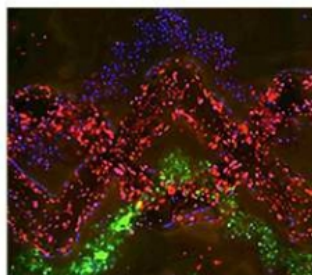
## Blood Vessels Via Printer

➔ Could tomorrow's surgeons create customized replacement tissue for patients just by hitting print? Two teams of Harvard bioengineers made big strides toward that goal in 2014, reporting two new 3-D-printing methods that help construct rudimentary blood vessels.

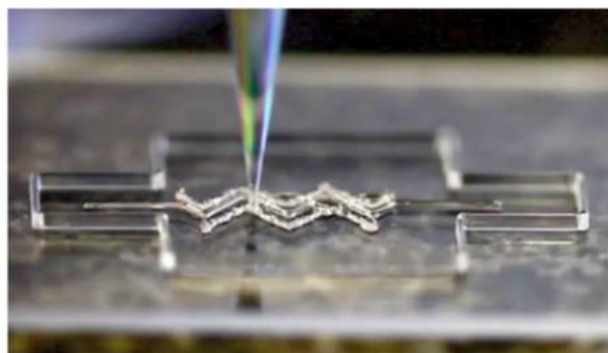
Each year, thousands of people die waiting for tissue and organ donations, which are scarce. For that reason, tissue engineers are working to build replacements, and they've managed to do it for sheetlike tissues, like the skin and bladder.

But replacement tissues for solid organs, such as the liver, heart or kidney, are tougher to construct because cells inside those tissues rely on a network of blood vessels that are difficult to replicate.

In February, Jennifer Lewis' team reported printing tissue pieces infused with the beginnings of blood vessels. They used a custom-built 3-D printer and special inks containing extracellular matrix — the naturally derived material that the body uses to knit cells into tissues. The printer builds tissue, layer by layer. As the print heads move, they squeeze out



Living cells (red) line a rudimentary blood vessel created by Lewis' method.



A 3-D printer built by Jennifer Lewis of Harvard and colleagues layers strand upon strand of biocompatible material, some containing cells, that they hope will form living tissue.

inks like toothpaste from a tube. Those inks solidify into worm-shaped gels, some of which contain living cells. To print blood vessels, the researchers made the worm-shaped gels from a special ink that, strangely, melts as it cools. This allowed them to suction out the resulting liquid, leaving tunnels that they lined with other cells to form rudimentary blood vessels.

In May, a second team, led by Ali Khademhosseini, reported building tiny blood vessels that branch or merge in three dimensions, as blood vessels do in human organs. First, they 3-D-printed wormlike strands of a gel called agarose, each serving as a cast of a tiny blood vessel. Around those casts, they poured a cell-rich liquid that solidifies into a biocompatible gel. Then they carefully tugged or suctioned away the agarose casts, leaving channels that they lined with cells to create simple blood vessels.

For now, Lewis' team is working to create kidney and bone tissue mimics for drug safety screening. Khademhosseini seeks to hone his 3-D-printing process to make replacement blood vessels for individual patients. —LACY SCHLEY



## The Brain's Kill Switch



➔ In July, researchers reported a strange discovery that helped unlock one of the great mysteries of the mind: consciousness.

Mohamad Koubeissi, a neurologist at George Washington University in Washington, D.C., and colleagues were trying to identify seizure sources in an epileptic patient's brain by electrically stimulating different regions. To the researchers' surprise, the patient temporarily lost consciousness when they stimulated an area of the brain called the claustrum, located just below the cortex (the outer layer of the brain).

"It was striking," Koubeissi says. "All cognition and awareness appeared to become paralyzed, with a complete return to baseline once we turned the stimulation off." He repeated the experiment at least 10 times, with the same result.

The finding is the first to support a theory proposed by DNA co-discoverer Francis Crick shortly before the neuroscientist's death in 2004. He and colleague Christof Koch hypothesized that the claustrum is a "conductor of consciousness" that integrates our internal and external perceptions into coherent thoughts and ideas. If the claustrum's role in consciousness is confirmed by other studies, it could lead to new ways to induce consciousness in people trapped in comas or persistent vegetative states.

—CHRISTIE ASCHWANDEN

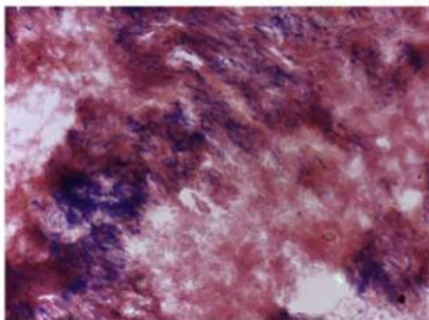
## Medieval Dental Plaque Offers Dietary Clues

➔ Let plaque sit on your teeth, and it will harden into dental calculus, the stuff your dental hygienist has to remove with a metal pick. But that crusty, calcified gunk actually preserves a wealth of dietary information, according to researchers studying four medieval skeletons from western Germany.

The University of Oklahoma's Christina Warinner and colleagues retrieved the genetic code of millions of microorganisms in the plaque, allowing them to determine what the person chewed or coughed up. They found thousands of bacteria species preserved in a rock-hard matrix of calcium.

The data, published in February, provide a snapshot of the medieval mouth — and more. "Calculi give you a window into health, diet and dynamic interactions with microbes," Warinner says.

Certain dietary staples haven't changed much, it seems. The plaque yielded pork and mutton biomolecules, along with wheat and microscopic remnants of a cabbage-like plant. "Some things, it turns out, are remarkably stable over time," Warinner says. —ANDREW CURRY



**Top:** Fossilized dental calculi coat the teeth of a jaw dating back to about A.D. 1100, found at a medieval site in Dalheim, Germany. **Left:** A sample of the calculus magnified 1,000 times reveals thousands of well-preserved oral bacteria. Red and purple staining differentiates two separate classes of bacteria.





Wild elephants, like this family, can apparently distinguish different human voices.

## Elephants Recognize Humans by Voice

→ We've known elephants can recognize each other as individuals, but it turns out they can pick *us* out of a crowd, too, distinguishing ethnicity, age and sex by our voices.

Researchers studying 48 wild elephant families played recordings of voices from two ethnic groups with distinct languages in Kenya's Amboseli National Park. Male voices from the Maasai, who are often hostile to elephants, caused the animals to sniff the air for danger and retreat into a defensive formation. But when researchers played male voices from the more

elephant-friendly Kamba, the pachyderms were much less perturbed. The elephants also weren't startled by voices of Maasai women and children, who don't hunt, revealing the animal's ability to discern subtle vocal differences.

"This has been one of the great aspects of studying elephants over the years, discovering that their cognitive abilities are extremely advanced in ways we may not have fully predicted," says University of Sussex behavior ecologist Karen McComb, whose study was published in March. —CARL ENGELKING