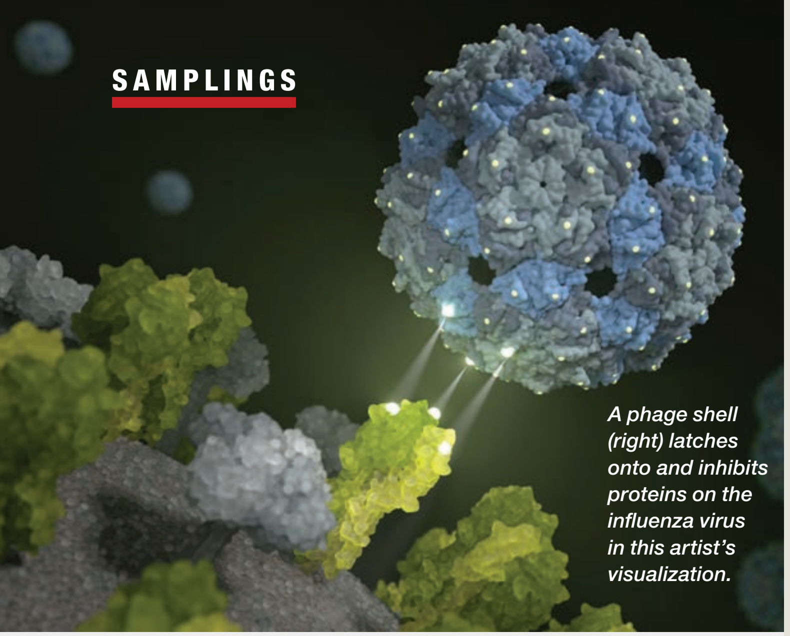


A phage shell (right) latches onto and inhibits proteins on the influenza virus in this artist's visualization.

BARTH VAN ROSSUM, FMP

Virus Bait

Current drug treatments for influenza have limited effectiveness because they attack the virus after it infects lung cells. In pre-clinical laboratory trials, however, a research team based in Berlin, Germany, has demonstrated a promising method for combating infection by blocking the virus before it invades lung cells. The method is also being investigated for its potential effectiveness against coronavirus SARS-CoV-2.

The interdisciplinary team sought ways to inhibit the action of hemagglutinin protein found on the surface of influenza viruses. This spike-like protein binds to sialic acid molecules on the surface of lung cells—the first step in the process that allows the virus to enter the cell. Previously developed inhibitors latch onto hemagglutinin, but only weakly. The natural virus mutations that arise in different strains of influenza every flu season can also render these inhibitors ineffective.

To overcome these problems, the Berlin researchers turned to phage viruses that infect bacterial cells but not human tissue [*see "Viruses: the Ugly, the Bad, and the Good," by Paul E. Turner, 5/19*]. A particularly well-studied example from the human gut, the Q-beta phage, stood out as a promising candidate. The phage's capsid—a shell containing genetic material—is composed of 180 identical proteins that are ideally spaced apart to fit the shape of hemagglutinin. "The structure of this capsid is known in exact detail," says Andreas Herrmann, head of molecular biophysics at Humboldt University of Berlin and one of the study's senior authors.

The team chemically modified the phage shell by studding it with sialic acids. When exposed to influenza in the laboratory, the phage shells latched onto any hemagglutinin spikes with which they came into contact. This binding vastly reduced flu viruses' ability to infect lung cells in both animal models and lab-grown human tissue. Should flu viruses develop resistance and no longer bind in the same way to sialic acids, according to the researchers, the bait molecules on the phage shell can easily be adjusted.

Phages can trigger immune reactions in humans even though they are not infectious. However, the phage shells were well-tolerated by both animal and human models. More studies will be needed before phage therapy can be developed into a potential weapon against influenza—or covid-19. "Eventually, if all these studies are promising, biotechnology resources have to be developed for large-scale production, and clinical trials [in human patients] are mandatory," Herrmann said. (*Nature Nanotechnology*) —*Adam Hadhazy*

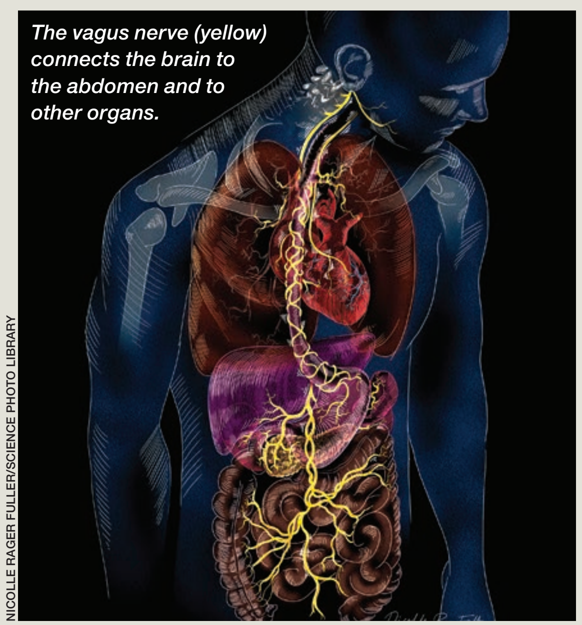
Gut-Brain Connection

Scientists have long known that the brain—specifically an area known as the brain stem—controls involuntary bodily functions, such as breathing and digestion. But a recent study of the gut-brain relationship suggests that processing for gut functions occurs in more regions of the brain than was previously understood. The study reveals a "road map" of pathways that connect the gut to parts of the brain responsible for emotion and complex thought.

Neuroscientists at the University of Illinois at Urbana-Champaign studied the gut-brain connection in rats. They injected the small intestines with viruses that infect nerve cells. These viruses served as tracers, traveling along the same neuronal pathways that a sensory signal would. Fluorescent proteins attached to the viruses allowed the scientists to trace the path a virus traveled through the body to the brain.

Over five days, the researchers watched as tracers made their way through sensory nervous systems. The fluorescent markers revealed connections between the gut and several different parts of the brain, including the brainstem. Signals from the gut also traveled to the amygdala, known for processing emotion, and the cortex, which handles such complex processes as memory and attention.

More research is needed to determine if this finding applies to the human brain. However, investigators believe the work provides insight into the inner workings of the mammalian brain. "We still have a lot to learn about the basic principles of how brains work—things that will hold true no matter what



The vagus nerve (yellow) connects the brain to the abdomen and to other organs.

NICOLLE RAGER FULLER/SCIENCE PHOTO LIBRARY

animal's head you found it in," said Coltan G. Parker, a neuroscience PhD candidate and lead author of the study.

Parker's colleague Elizabeth A. Davis, now a postdoctoral scholar at the University of Southern California, said the finding could help researchers understand the science underlying the gut-brain interactions that many people commonly experience. "Examples include why some people get nauseated when they are anxious, [or] why people get 'hangry' (angry because they are hungry)," she said. (*Autonomic Neuroscience: Basic and Clinical*) —*Jane C. Hu*

An Early Bilaterian

An artist's rendering of Ikaria wariootia, a 555-million-year-old wormlike organism

SOHAIL WASIF/UCR

Most modern animals follow the same basic body plan: openings at either end connected by a continuous gut. The emergence of animals with this blueprint, bilaterians, marked a major development in the evolution of animal life. Biologists had predicted that the earliest bilaterian would be simple and small. But because it would have had a soft body, finding evidence of it in the fossil record seemed unlikely. However, an international team has uncovered fossils of an ancient, wormlike organism that could fit the bill.

During his doctoral research at the University of California Riverside, paleontologist Scott D. Evans and his advisor, Mary Droser, investigated sandstone deposits in southern Australia. They spotted tiny impressions shaped like grains of rice in a rock layer estimated to be 555 million years old. These fossils were too small to examine in detail with standard tools, such as photographs and rubber molds. A three-dimensional laser scanner, however, revealed a spindle-shaped organism less than 7 millimeters (mm) long and 2.4 mm wide that exhibited the hallmarks of a bilaterian. One end of the fossil tapered to a point, while the other was wider and rounder.

The team determined that the organism represented a distinct genus and species of bilaterian, which they named *Ikaria wariootia*. Based on the rock layers in which it was found, the researchers concluded that *I. wariootia* would have lived on a shallow prehistoric seafloor. These rock layers also contain tiny fossilized burrows that the scientists contend *I. wariootia* created as it scooted beneath a light blanket of sand, likely scavenging for organic matter. These abilities to scavenge and displace sediment imply that *I. wariootia* had simple sensory organs in addition to a mouth, through-gut, and anus.

The team speculates, but cannot confirm, that *I. wariootia* may be the earliest ancestor of bilaterians. "The fossil record only captures a fraction of the life that existed on Earth, and we caught a very small but important part of that history," said Evans, who is now at the Smithsonian Institution. (*Proceedings of the National Academy of Sciences*) —*Ashley Braun*

Dental Record

Unlike the great apes, humans have extremely dependent young, and women have a long post-reproductive lifespan. The evolutionary drivers of this unique lifestyle have been difficult to determine, in part because researchers had no scientific processes to investigate life histories in the fossilized remains of human ancestors. Recently, however, researchers developed a new method for identifying important events, such as childbirth and menopause, by analyzing human teeth.

Led by anthropologist Paola Cerrito at New York University, a team of scientists studied forty-seven teeth from fifteen individuals with known life histories. They used various microscopic imaging techniques to examine the dental tissue cementum, which covers the root of the tooth. Cementum grows throughout a person's life and accumulates annually in a series of bands, similar to tree rings. The team measured the total thickness of the cementum, as well as the distance from each detectable band to the edge of the cementum layer.

The researchers used each individual's age and cementum thickness to calculate the rate of cementum growth, allowing them to determine when each cementum band formed. They then examined the bands for changes in microstructure and found that bands with altered structure corresponded in timing with life events and stressors known to alter physiological function.

In teeth from females, the researchers found altered cementum bands that corresponded to reproductive events. Both male and female teeth showed cementum changes if an individual was affected by an illness such as malaria or HIV. More unexpectedly, said Cerrito, stressful events, such as incarceration and relocation, were recorded in the cementum. "We had no idea that there was something in our bodies that would record these important physiological events for the entirety of our life," she said.

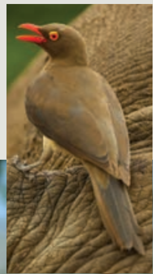
Stressful events form darker lines (running diagonally, indicated by arrows) along the cementum (yellow bar across its width) of teeth.

PAOLA CERRITO

Cerrito noted that the method is limited by a number of factors. Cementum growth rate varies between individuals, so the age at death (or tooth extraction) needs to be known. In addition, researchers cannot currently differentiate types of stressful events without knowledge of an individual's life history. Cerrito is now working on determining an "elemental fingerprint" that will allow for such discrimination. "We are pretty confident that each stressor is going to alter the metabolism in its own way." (*Scientific Reports*) —*Niki Wilson*

Rhino Sentinels

Critically Endangered black rhinos *(Diceros bicornis)* have poor vision, relying more on smells and sounds to sense their surroundings. They are vulnerable to poachers, who approach quietly and from downwind. However, rhinos may have a defensive ally. Red-billed oxpeckers (*Buphagus erythrorynchus*) that ride on rhinos' backs seem to function as security alarms.



JED BIRD

New research suggests that black rhinos listen to the alarm calls of oxpeckers (inset) to warn them when people approach.

DALE R. MORRIS

Oxpeckers, perched on the backs of grazing mammals, pick off parasites, such as ticks, from their hosts' skin. But they are also parasites, feeding on blood from open wounds. From the Swahili name for the oxpecker—*Askari wa kifaru*, or "rhino's guard"—environmental scientists Roan Plotz, of Victoria University, Melbourne, Australia, and Wayne Linklater, of California State University Sacramento, suspected the birds provided an additional service that led rhinos to tolerate this practice.

The two researchers designed a series of experiments to test whether black rhinos in Hluhluwe-iMfolozi Park in KwaZulu-Natal, South Africa, used oxpecker alarm calls as warnings. Over the course of twenty-seven months, they conducted 200 searches and counted the number of oxpeckers found on rhinos.

When the scientists sought out tagged rhinos, which they were able to locate and sneak up on using radio telemetry, the majority had oxpecker riders. But when Plotz and Linklater looked for untagged rhinos, trying to approach them without the aid of radio telemetry, those with oxpeckers were much more difficult to find. By comparing the two groups, the authors calculated that the birds helped rhinos avoid human detection 40 to 50 percent of the time.

The scientists next investigated whether rhinos eavesdrop on oxpecker alarm calls. They systematically snuck up on eleven tagged rhinos from downwind. In eighty-six trials, rhinos without oxpeckers failed 77 percent of the time to notice the approaching researcher. But rhinos with oxpeckers that called out in alarm detected the researchers "every single time," said Plotz.

The more birds a rhino carried, the farther away it was able to detect an oncoming person. Although the calls did not indicate the direction of the threat, the rhinos almost always turned to face downwind. This behavior confirmed for the researchers that the rhinos do indeed eavesdrop on oxpecker calls. Reintroducing the birds to areas where they are now largely absent might be a worthwhile rhino conservation tool, the authors concluded. (*Current Biology*)

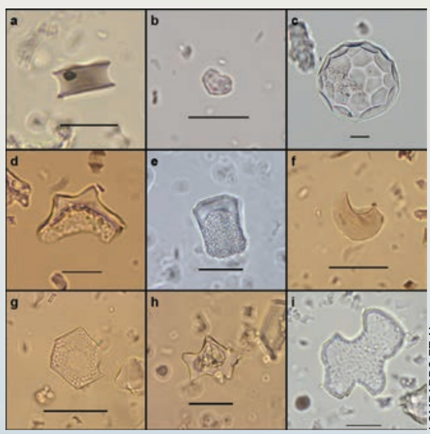
—Lesley Evans Ogden

Early Crop Cultivation in Amazonia

Hunter-gatherers are thought to have inhabited the Amazon basin as early as 10,000 years ago. Now, a study provides the first archaeological evidence that these people were cultivating crops that are the ancestors of today's cassava, squash, and corn, among others. The findings suggest that the Amazon region could be considered one of the major centers of early crop cultivation, along with previously known areas in China, the Middle East, Mexico, and the Andes.

Umberto Lombardo, an earth scientist at the University of Bern in Switzerland, and colleagues sampled sediments from eighty-two "forest islands" in the Bolivian savanna. Forest islands are areas where human inhabitants deposited food waste, shells, and other organic material for thousands of years. Their refuse created mounds of rich soil that rise above the surrounding savannah—which is often flooded—and allow patches of forest to grow. Radiocarbon dating of soil from thirty-one forest island sites shows that humans inhabited the area for about 8,000 years, starting around 10,850 years ago.

The researchers processed the soil samples in order to extract microscopic pieces of silica known as phytoliths, which form when sediment mineralizes inside a plant. Some of these phytoliths were identified as belonging to specific plants based on their shape. The researchers found scalloped spheres that formed inside squash rinds, heart-shaped phytoliths from a cassava ancestor, and wavy cylinders from corn cobs, suggesting that these crops were once cultivated in the area.



LOMBARDO ET AL.

The shape of tiny mineralized sediments found in Amazonian forest islands reveals the plant species once cultivated there.

The corn cob phytoliths were matched to a variety of corn thought to have been brought to the Amazon from Mexico, where it was first domesticated. Lombardo and his colleagues found the pieces they dated to be about 6,850 years old, suggesting that corn's domestication in Mexico occurred hundreds of years earlier than previously thought.

Today, the forest islands are no longer inhabited by humans. But when they were, the region saw significant environmental transformations, such as changes in the course of rivers, according to Lombardo. Human actions also led to the creation of habitat for some species, such as the Critically Endangered blue-throated macaw (*Ara glaucogularis*), which lives only in the forest islands. Future research may further investigate ecosystem changes and how human inhabitants reacted to them, Lombardo said. (*Nature*)

—Kati Moore

JAVIER RUIZ-PÉREZ