that because *Eomaia* doesn't belong to a modern order, it leaves the major discrepancy unchanged. In that case, paleontologists will have to wait for more gems to emerge from Liaoning or elsewhere. **–ERIK STOKSTAD**

COSMOLOGY

Eternal-Universe Idea Comes Full Circle

The branes are planes and make the cosmos wane. So says a new theory published online by *Science* this week (www.sciencexpress.org). Surprisingly, the theory—an alternative to the standard, inflationary picture of the formation and demise of the universe—describes a sheetlike "brane" universe that eternally dies and rises from its ashes, hearkening back to the long-discarded steady-state model of a cosmos without beginning or end.

"It seems like a consistent philosophical framework. Time is infinite, space is infinite, and they have always been here," says Cambridge University's Neil Turok, one of the authors of the theory. "It's exactly what the steady-state–universe people wanted. Our model really realizes their goal."

The new idea is an extension of the ekpyrotic or "Big Splat" theory, which Turok and other physicists introduced last year as an alternative to inflation (*Science*, 13 April 2001, p. 189). Inflationary theory says that for less than 10^{-30} of a second, the universe expanded at an incredible rate—an idea that can explain features of our universe such as the astonishing similarity of widely separated regions in space and the nature of the cosmic background radiation. Turok, along with Paul Steinhardt of Princeton University and two other colleagues, sought an alternative to inflation based upon the mathematical framework of M theory, a popular successor to superstring theory. The result: the ekpyrotic universe, which describes the birth of our universe in the collision of enormous four-dimensional membranes, or branes. Not only did the ekpyrotic model make similar predictions to inflationary theory, it got rid of the troubling "singularity" of the big bang itself.

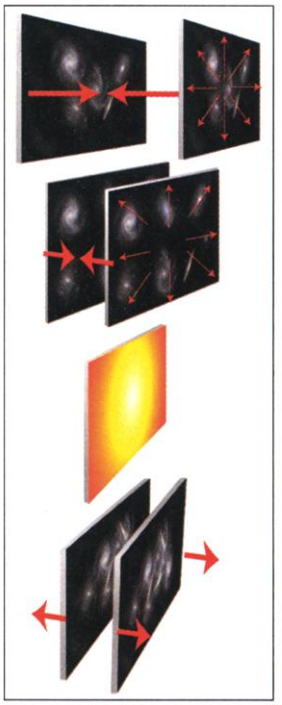
The latest version is a more sophisticated variant of the original ekpyrotic theory. Two infinite branes—our own universe and a "mirror universe"—live a tiny fraction of a meter apart. "If you wait long enough, the branes approach one another," says Steinhardt. They collide, and the energy of that collision creates all the matter and energy in our universe. The membranes "bounce" and separate again. The newborn universe, on its brane, then evolves and eventually burns out.

The theorists were surprised to realize that the collapse-and-bounce process repeats itself ad infinitum. Because the surfaces of the membranes are constantly stretching—thanks to an expansion factor known as the cosmological constant—the "ashes" of each dying universe are diluted and scattered, making it possible to bounce again and again without causing a buildup of brane-bound debris that would end the process. The universe is born, dies, and is reborn again.

The inventor of the inflationary-universe model, physicist Alan Guth of the Massachusetts Institute of Technology in Cambridge, Massachusetts, says the new theory's links to M theory and string theory are "exciting" but don't guarantee its future. "I think it really does come down to the physics of the bounce," Guth says.

To Turok, the new theory is not only mathematically consistent but aesthetically pleasing. "I never had any strong philosophical opinion of this before I worked on it. I was very skeptical of cyclic models," he says. "But as soon as I started working on this, I appreciated that time marched on—that there was no beginning of time." Will the new theory catch on? Time will tell.

–CHARLES SEIFE



No end. In new model, colliding sheetlike "brane" universes stamp out repeated big bangs.

BIODEFENSE

New Anthrax Vaccine Gets a Green Light

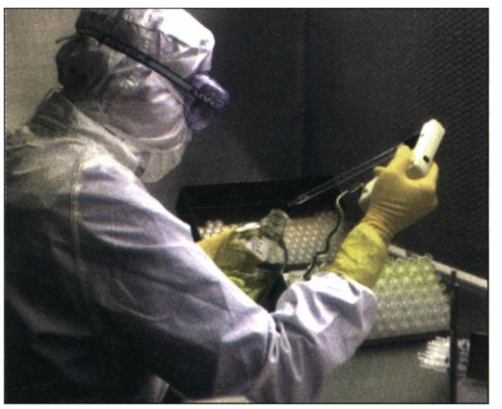
After years of trying to interest people in a new, genetically engineered anthrax vaccine, researchers learned last week that the U.S. government wants to buy one—in a hurry. The National Institute of Allergy and Infectious Diseases (NIAID) in Bethesda, Maryland, announced 18 April that it is seeking bids to develop and test candidates. The Department of Health and Human Services (HHS) plans to follow up with a contract to buy 25 million doses of the winner, to be added to the nation's emergency stockpile. President George W. Bush has already requested $250 million in his 2003 budget for the project.

The only anthrax vaccine licensed in the United States today is a mixture of proteins produced by a tame form of *Bacillus anthracis*, the bacterium that causes anthrax. This anthrax vaccine adsorbed (AVA), as it's called, was developed for animal-hide workers in the 1950s and is now used primarily by the military. Although some claim that AVA causes serious side effects, a panel from the Institute of Medicine concluded last month that it is effective and reasonably safe.

But it isn't ideal for general use, says Carole Heilman, director of NIAID's division of microbiology and infectious diseases, primarily because immunity builds up slowly. Vaccinees require a series of six shots over 18 months, followed by a yearly booster. Instead, NIAID wants a vaccine that requires no more than three shots and that would work so rapidly that it could be given after exposure to anthrax spores.

Researchers have been exploring many alternatives to AVA. But because speed is of the essence, says Heilman, NIAID has decided to go with the most extensively tested new vaccine: one based on a protein in the bacterium's toxin complex called protective antigen (PA). This protein is part of the mélange present in AVA, and researchers believe that it is the main contributor to protection. However, they don't know how potent a vaccine based on PA will be in humans. Studies by Arthur Friedlander and others at the U.S. Army Medical Research Institute of Infectious Diseases in Fort Detrick, Maryland, have shown that recombinant PA, produced by non–spore-forming *B. anthracis*, protects rhesus monkeys against inhalational anthrax; they also suggest that fewer injections of the vaccine might suffice to elicit immunity and that the vaccine might have fewer side effects than AVA.

Some say the choice for injected PA is needlessly conservative, citing other, more promising approaches. "It's very disappointing that [NIAID] is sticking to the tried and true," says Uma Ryan, CEO of AVANT Im-



Yesterday's vaccine. The government wants a modern successor to AVA for the civilian population.

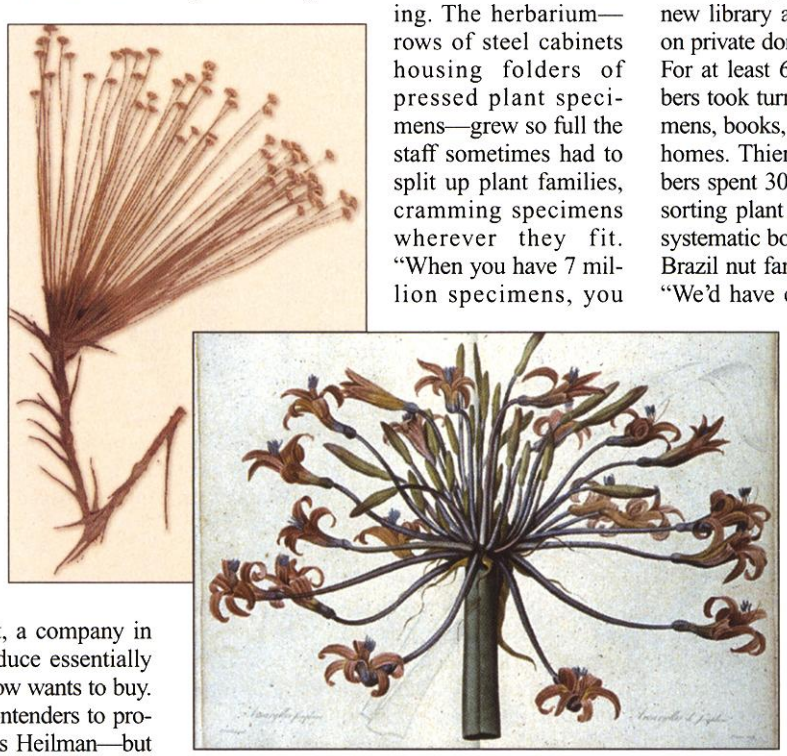
CREDITS: (TOP TO BOTTOM) C. SLAYDEN WITH IMAGES FROM NASA; SHAWN JACOBSON/AP

munotherapeutics, a company in Needham, Massachusetts, that is developing an oral, one-dose anthrax vaccine. This vaccine, made from a weakened cholera bacterium that produces PA, would be a better way to protect the civilian population because it acts rapidly, Ryan contends. And she claims it could be tested quickly.

But others support NIAID's decision. Stephen Leppla, an anthrax researcher at the National Institute of Dental and Craniofacial Research in Bethesda, says vaccines like AVANT's that deliver PA in a new way are intriguing but not yet ready for prime time. They might pan out in the long run, Leppla says, "but there's pretty wide agreement that, if we want to have something within a few years, recombinant PA is the way to go."

The military also wants to replace AVA with a new vaccine, and its Joint Vaccine Acquisition Program has contracted with DynPort, a company in Frederick, Maryland, to produce essentially the same vaccine that HHS now wants to buy. DynPort is also one of the contenders to produce the civilian vaccine, says Heilman—but she says several other companies have already expressed interest in the contract as well, and the government could end up with two vaccines made by two different manufacturers.

–MARTIN ENSERINK AND ELIOT MARSHALL



A bit of botany. The New York Botanical Garden houses history, including this 1969 Brazilian plant specimen, *Paepalanthus incanus* (*left*), and an image of Amaryllis Josephinae, a flower named for Josephine Bonaparte, taken from the 19th century book *Les liliacées* (*above*).

CREDIT: NYBG

MUSEUMS

In New York City, a Building Blooms

BRONX, NEW YORK—The New York Botanical Garden is forever changing. Riots of color—fiery tulips, lush roses, golden maples—rise and fade across its 100 hectares as the seasons change costume. But next week, the grand old garden unveils some scenery that's here to stay: the $100 million International Plant Science Center. The new center houses a one-of-a-kind collection of plants and books and opens the door to a new era of plant science.

Founded in 1891, the New York Botanical Garden (NYBG) has the richest herbarium in the Western Hemisphere, with 6.5 million plant specimens, from a Pleistocene-era gnarl of moss to a rare orchid recently found in Borneo. Its library boasts 775,000 rare books, seed catalogs, and other exotica—an estimated three-quarters of the world's systematic botany literature and published floras. "This is one of the greatest botanical collections in the world," remarks Neotropical plant specialist William Anderson, a curator at the University of Michigan Herbarium.

Like a celebrity closet bursting at the seams, however, the garden long ago outgrew its original limestone-and-brick building. The herbarium—rows of steel cabinets housing folders of pressed plant specimens—grew so full the staff sometimes had to split up plant families, cramming specimens wherever they fit. "When you have 7 million specimens, you don't want to lose something," jokes Barbara Thiers, director of NYBG's herbarium. "We were absolutely full." What's more, the original building is classic turn-of-the-century architecture: high ceilings, huge windows, and drafty rooms. Lovely, but not exactly a pristine environment for preserving rare dried plants and timeworn books.

Like its collections, plant science at NYBG could use some updating to join the molecular revolution sweeping the field. So NYBG has launched a 15-year, $225 million effort to modernize. "While we remain committed to traditional studies of plant systematics, we're also very interested in using new molecular techniques to learn more about plants than ever before," says garden president Gregory Long. Next year, NYBG plans to break ground on a new plant science lab, funded primarily by Pfizer. To that effect, the garden recently formed a genomics research consortium with Cold Spring Harbor Laboratory and New York University. And in coming years, Thiers hopes to post NYBG's entire specimen collection online in a virtual herbarium (www.nybg.org/bsci/cass), with digital images and brief biographies of the plants, including finds by Charles Darwin, British captain James Cook, and western explorer John Fremont.

As part of its makeover, the NYBG 5 years ago began renovating the top of its original building and adding a west wing for the new library and herbarium. The effort relied on private donations, public funds, and sweat. For at least 6 months, dozens of staff members took turns wheeling carts of plant specimens, books, and other materials to their new homes. Thiers estimates that 50 staff members spent 3000 hours pushing, stacking, and sorting plant fragments alone. Scott Mori, a systematic botanist at NYBG who studies the Brazil nut family, calls the effort a marathon. "We'd have competitions to see who could move the greatest number of specimens," Mori laughs.

The result is a rare example of botany in avant-garde surroundings. "Such a magnificent structure should provide a great setting for the best possible research in our field," says Missouri Botanical Garden director Peter Raven, who will speak at a 1 May symposium to launch the plant center's public opening. Outside, the new wing, wearing a limestone surface and copper trim, reflects its historic neighbor. Inside, the herbarium is spartan and cool, like a modern loft, with bare floors, exposed ductwork, and angled windows overhead. Banks of coral, compact steel cabinets—expanded and contracted with the turn of a wheel—line the well-lit space, leaving room for desks and microscopes down the middle. Each cabinet is only half-full, says Thiers, with space for 25 years of expansion.

Atop the new wing and renovated museum space, the library offers dappled light and geometric lines, with gray hues offset by cherry wood and a brightly lit reading room. A new gallery showcases the library's treasures, including one of the earliest known versions of *Circa Instans*, an A.D. 1190 formulary of medicines, listing plants and other ingredients in popular remedies of the day. Just down the hall, the rare books room holds 5000 other pre-Linnaean titles, published before 1753—shelves of botanical adventures and ideas, often penned in Latin and German, resembling huge family bibles or thumbed-through journals dressed in colorful spines. "These are the original descriptions of some plants, so they're very scientifically valuable, and now they're more accessible," says John Reed, director of the library.

Indeed, accessibility may be the renova-