boosts the immune response to a viral protein antigen, he says. The problem is especially important for vaccines that are based on a single viral protein, because one protein typically does not stimulate strong immune responses if used alone.

Most vaccine researchers are looking for ways to induce immune responses that will protect an individual from infection. But some, including the groups led by Zagury, Goldstein, and Jonas Salk of the Salk Institute in La Jolla, California, are experimenting with vaccines in people already infected with HIV. Salk, Brian Henderson, and Alexandra Levine of the University of Southern California Medical School are currently testing a therapeutic vaccine that contains killed whole AIDS virus as an immunogenic agent. Fourteen HIV-infected people with signs of disease have received it and as yet, no dramatic effects, beneficial or adverse, have been observed in anyone.

As researchers pursue different strategies for developing an AIDS vaccine, the lack of a good animal model in which to screen the vaccines becomes more serious. Only a limited number of chimpanzees are available for AIDS research, a problem addressed at a recent conference sponsored by the World Health Organization in Geneva. "There was a consensus that simian immunodeficiency virus (SIV) infection in macaques is an excellent model for testing both prototype vaccines and drugs," says Patricia Fultz, of the Yerkes Primate Center in Atlanta, Georgia. Monkeys infected with SIV experience immune suppression and become highly susceptible to various infections. In addition, the virus itself has about 40% sequence similarity to HIV-1.

Many research groups, in addition to those mentioned here, are working to create a vaccine for AIDS and some are attempting novel approaches. Scientists have known since they began to work on an AIDS vaccine that it would not be easy, but perhaps no one realized it would be so difficult. Hilleman notes that it took 13 years to develop a vaccine for hepatitis B. "It certainly is going to take as long to develop a vaccine for AIDS," he says. ■

DEBORAH M. BARNES

ADDITIONAL READING

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Mathematics at 100

A snowflake, whooping cough, the superconducting supercollider, water passing under a bridge, and the price of a gallon of gas—what do they have in common? They were all part of a gallop through "Mathematics in the Sciences," a National Academy of Sciences (NAS) forum held last week to commemorate the centennial of the American Mathematical Society. With so eclectic a fare on offer, everyone there—on stage and off—was uninitiated in something, but all were united in the "power and beauty" of mathematics, as David Gross of Princeton University put it. The forum was designed "to demonstrate the large-scale involvement of math in the working sciences," said Felix Browder of Rutgers University, "even though it goes against the prejudices of many—both scientists and mathematicians."

Gross blithely explained how experimental particle physics lay some 17 orders of magnitude distant from the "who knows what" point to which String Theory leads. Put on a log scale it becomes "only a factor of 40." The superconducting supercollider would close the gap some, but not much. Nevertheless, "without the SSC, particle physics will die." Leo Kadanoff of the University of Chicago gave a lesson in the meaning of *chutzpah*, by following up a display of Leonardo's drawings of turbulence in water with his own. Chaos was his topic of course, and he showed how fine is the line between stability and chaos, and how there is chaos in order and order in chaos.

Robert May, a theoretical ecologist at Princeton University, could not match Leonardo sketches, but showed slides of stained glass windows in a church in Sussex instead. Population dynamics was his topic—of birds, and insects, and pathogenic organisms. "Chaos explains sex, not the weather," he said, which struck a chord. In the natural world, deterministic events can give the illusion of chaos, and chaos the illusion of determinism, and you have to distinguish between them. "Math is a way of thinking clearly, no more, no less." Herbert Scarf of Yale University needed no introduction as an economist when he said that the model he was about to describe bore no relation to the real world, but would illustrate his point. It did. Systems as huge and apparently chaotic as the national economy can be modeled with deceptively simple, but elegant, math. And Benoit Mandelbrot of IBM's Thomas J. Watson Research Center, Yorktown Heights, New York, showed once again that the world is made of bits and pieces—fascinating bits and pieces that continue to astonish, no matter how many times you see the phenomenon: namely, fractals.

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Dirac once said, "I'm not interested in proofs, only what nature does." And, it seems, mathematicians are inexorably drawn to nature, not just describing what is to be found there, but in creating echoes of natural laws. Mathematicians do not just "think of things out of nothing," said Gross, citing a famous conversation; "they are discovering what is real and natural." It is for this reason that so often math—to a mathematician—seems beautiful. "If math is about structures that are part of the real world, it is not surprising it is a powerful tool, not surprising that what we find as beautiful are those things that match the real world. Our minds have evolved to find this pleasing." ■ **ROGER LEWIN**