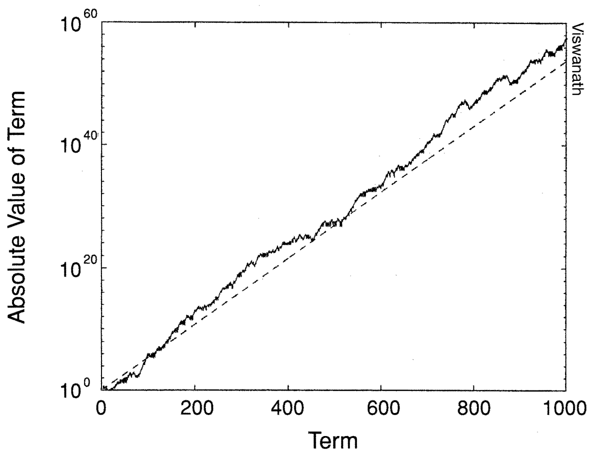
nell University.

In a different mathematical context involving so-called random matrix multiplication, Furstenberg and Kesten had proved that in number sequences generated by certain types of processes having an element of randomness, the value of the *n*th term of the sequence gets closer to the *n*th power of some fixed number. However, they provided no hint of what that fixed number might be for any particular sequence.

Because random Fibonacci sequences fit into this category of sequences, Vis-wanath's new constant represents an accessible example of these fixed numbers.

"It is a beautiful result with a variety of interesting aspects," Trefethen says. It's a nice illustration, for example, of how a random process can lead to a deterministic result when the numbers involved get very large.

Moreover, although Viswanath's result by itself has no obvious applications, it serves as an introduction to the sophisticated type of mathematics developed by Furstenberg, Kesten, and others. That mathematical machinery has proved valuable in accounting for properties of disordered materials, particularly how repeated random movements can lead to orderly behavior, Devlin says.



Despite significant fluctuations, the absolute values of the first 1,000 terms of a typical, computer-generated random Fibonacci sequence show a clear trend to larger values, fitting a pattern of exponential growth (dashed line).

Such mathematics underlies explanations of why glass is transparent and how an electric current can still pass in an orderly fashion through a semiconductor laced with randomly positioned impurities.

Viswanath's original work was done at Cornell University, under Trefethen's supervision. Trefethen and Oxford's Mark Embree have recently studied slightly modified versions of the random Fibonacci sequence. If, for example, one combines the last known term with half the previous term, adding or subtracting according to the toss of a coin, the sequence's numbers decrease at a certain rate, displaying exponential decay.

By using fractions other than one-half, it's possible to find fractions for which one gets exponential decay, exponential growth, or merely equilibrium. "All this quickly gets under your skin when you start trying it on the computer," Trefethen says, adding that it becomes an addictive pastime.

There's still plenty of room for mathematical exploration and experimentation in a problem that began centuries ago as a decidedly unrealistic model of a population of rabbits. □

Biology

From Chicago at the annual meeting of the American Society for Microbiology

A toxin at the heart of Lyme disease?

Although scientists recently sequenced all the genes of *Borrelia burgdorferi*, they're still struggling to explain how this spiral-shaped bacterium causes the varied symptoms of Lyme disease. Beginning as a simple rash, Lyme disease can go on to cause fatigue, paralysis of the face and limbs, headaches, and even behavioral changes. Sam T. Donta of Boston University School of Medicine and his colleagues now report that the microbe may produce a nerve cell toxin similar to ones made by the bacteria that cause botulism and cholera.

The initial computer-aided scan of the *B. burgdorferi* genome did not reveal obvious nerve-cell toxins, but such searches are notoriously unreliable, notes Donta's colleague Mark J. Cartwright. Consequently, the researchers used strands of the DNA of known bacterial toxins to fish out similar genetic sequences within the Lyme bacterium. They found a gene for a possible toxin and showed that its protein induces cells to become rounder, apparently by altering their internal skeleton.

Eventually, nearly 40 percent of cells exposed to this protein die, reports Cartwright. The next task is to prove that the bacterium actually secretes the toxin during an infection, he says. *—J.T.*

One small bacterial genome, to go

Before attempting to create a new life-form in the laboratory, one group of scientists is pausing to allow reflection on the consequences of such an effort. Their experiment concerns the intriguing issue of how few genes a free-living organism needs (SN: 9/28/96, p. 198).

The bacterium with the smallest known genome, *Mycoplasma genitalium*, has just under 500 genes. Scientists at The Institute for Genomic Research (TIGR) in Rockville, Md., have been deactivating those genes one by one to determine which are required for life. The final tally stands at around 300 essential genes, says J. Craig Venter, former president of TIGR.

To test whether these 300 or so genes alone can sustain life, Venter and his colleagues have contemplated making an artificial bacterial chromosome containing only those genes. The biologists would then slip this chromosome into an empty bacterial membrane and see whether their creation springs into action. The researchers have temporarily halted their work to give a group of bioethicists and religious scholars time to develop a report on the implications of the provocative experiment.

There's no delay, however, in Venter's controversial plan to quickly sequence all the genes in the human body (SN: 5/23/98, p. 334). His new company, Celera Genomics in Rockville, Md., could have the complete human genome next summer, he says. *—J.T.*

DNA may reveal a fly's favorite eatery

In the tropics of the Americas and elsewhere, beware the bite of sand flies. These insects, which feast at night, often transmit disease-causing parasites when they procure a blood meal from their victim. Sand flies can infect people with the parasites, called leishmaniase, that cause a family of potentially fatal diseases that afflict an estimated 12 million people worldwide.

The source of the parasites must be another mammal that the sand fly bites. Identifying those natural hosts might help researchers devise better ways to control the spread of the disease. Cristian Orrego of San Francisco State University and his colleagues are using genetic evidence to tackle that challenge. The scientists have already shown that they can isolate hamster DNA from the flies' blood meals after they allow the insects to feed upon the rodents in the laboratory. They now plan to capture sand flies in Peru, isolate mammalian DNA from the insects, and compare it with the DNA of mammals known to reside in the tropics. *—J.T.*