PERSONAL GENOMES

Individual sequencing could be around the corner

BIOTECH | The Human Genome Project's working draft sequence, which was completed to much fanfare in June 2000, took about a dozen years and more than $300 million to complete. The result was a composite map of the DNA from several people—a sort of averaged genetic picture of a human. But a growing number of companies are working on advanced technologies that could make it possible to have your own individual genome sequenced in a day, perhaps for as little as a few thousand dollars.

No one's genetic makeup matches "the human genome" exactly; the differences are what give one person brown eyes and another blue or make some people more susceptible to heart disease. The new technologies could give anyone access to the unique,letter-by-letter sequence of his or her entire genome and help doctors detect the variations that signal health problems down the road.

Today's sequencing methods are costly and slow in part because for each DNA letter read—of the roughly three billion in a human genome—researchers need to synthesize a separate copy of the DNA strand. Making the copies requires several chemical reactions;then you have to separate and identify the newly made strands. In contrast,two new techniques being developed could read the sequence directly from one DNA molecule. The first method, called "nanopore sequencing," involves pushing a strand of DNA through a tiny hole surrounded by sensors that detect the electrical changes caused by each DNA letter. The second takes advantage of an enzyme called DNA polymerase, which copies DNA inside our cells. Researchers use specialized optics to detect each letter added as the enzyme copies the original DNA strand.

In May, Palo Alto, CA-based Agilent Technologies signed an agreement with Harvard researchers Daniel Branton and Jene Golovchenko to further develop nanopore sequencing, which Branton coinvented *(see "Hole in the Wall Offers Cheaper Sequencing,"* TR *May/June 1998)*. Also this year, Woburn,MA-based U.S. Genomics received its first patents on technologies that combine the two direct techniques. Thanks to these and several other efforts *(see table)*, the dream of sequencing a human genome in just a day could be a reality in two to five years, says George Weinstock, co-director of the Baylor College of Medicine Human Genome Sequencing Center in Houston. "They're all very clever techniques," he says. "We're getting very close to having them in hand."

Though the new sequencing tools will initially be used for biomedical research, they could eventually find their way into doctors' offices, not only providing for quick gene-based diagnosis of a host of diseases, but also helping doctors choose medicines tailored to individual patients. The expected price tag to sequence your genome—perhaps $5,000 to $30,000—might seem steep, but "it's kind of a life investment," says Harvard Medical School biophysicist George Church. "I would pay $10,000 to get my genome sequenced…rather than buying a second car." —*Erika Jonietz*

SEQUENCE SEEKERS

Others pursuing single-genome techniques

NANOPORE	POLYMERASE
Amersham Pharmacia Biotech (Piscataway, NJ)	LI-COR Biosciences (Lincoln,NE)
Eagle Research (Broomfield, CO)	Solexa (Little Chesterford, England)
EIC Laboratories (Norwood, MA)	

BUILDING A GREEN FUTURE

ENERGY | Picture that monthly envelope from the electric company and imagine that it contains not a bill but a statement of credit—every month. That's the future of homes and other buildings, as seen by the U.S. Department of Energy. The agency hopes that its new road map for building-technology research and development will help make this green vision a reality by 2020.

Developed in conjunction with the building industry, the road map sets goals for improving building "envelopes"—walls, windows, foundations and roofs. According to Mark Ginsberg, the agency's deputy assistant secretary in the Office of Building Technology, shortcomings or defects in a building's envelope can be responsible for as much as half of its energy consumption: poor insulation wastes heat, for example, and air leaks make air conditioners work overtime. The department's funding of research for the next two decades, Ginsberg says, is meant to produce "the next generation of insulation, roofing materials and building products that will perform significantly better than what we have today."

Instead of replacing a roof, for example, you might someday be able to simply spray a plastic foam over the existing shingles that provides not only waterproofing but also an additional layer of insulation. Intelligent lighting and climate control systems could learn your preferences and adjust each room to suit your needs as you move through your home—making the most efficient use of heating, cooling and electricity. And solar cells integrated into not only roofs, but exterior walls as well, could help a building generate its own power.

"My own personal goal," Ginsberg says, "is 120 percent energy efficiency—buildings that use so little energy, and produce their own,that they give back to the grid." And, come bill time, they'd give back to their owners as well. —Lauren Gravitz

JAMES YANG