INTERNATIONAL
Herald Tribune

Scientists transplant genome of bacteria

By Nicholas Wade
Thursday, June 28, 2007

Scientists at the institute directed by J. Craig Venter, a pioneer in sequencing the human genome, are reporting that they have successfully transplanted the genome of one species of bacteria into another, an achievement they see as a major step toward creating synthetic forms of life.

Other scientists who did not participate in the research praised the achievement, published Thursday on the Web site of the journal Science. But some expressed skepticism that it was as significant as Venter said.

His goal is to make cells that might take carbon dioxide out of the atmosphere and produce methane, used as a feedstock for other fuels. Such an achievement might reduce dependency on fossil fuels and strike a blow at global warming.

"We look forward to having the first fuels from synthetic biology certainly within the decade and possibly in half that time," he said.

Richard Ebright, a molecular biologist at Rutgers University, said the transplantation technique, which leads to the transferred genome's taking over the host cell, was "a landmark accomplishment."

"It represents the complete reprogramming of an organism using only a chemical entity," Ebright said.

Leroy Hood, a pioneer of the closely related field of systems biology, said Venter's report was "a really marvelous kind of technical feat" but just one of a long series of steps required before synthetic chromosomes could be put to use in living cells.

"It's a really worthy accomplishment, but I hope it doesn't get hyped to be more than it is," Hood said.

One reason for Venter's optimism is that he says his institute is close to synthesizing from simple chemicals an entire genome, 580,000 DNA units in length, of a small bacterium, Mycoplasma genitalium. If that genome can be made to take over a bacterium using the method announced Thursday, Venter should be able to claim that he has made the first synthetic life form. The bacterium would be identical to nature's version, but would demonstrate how precise control could be achieved over every aspect of the machinery of living cells.

Biologists have long been able to move useful genes into bacteria and other organisms in a process called genetic engineering. The idea of synthetic biology is to carry out genetic engineering in a more extensive and systematic way.

Synthetic biologists, who held their third annual meeting in Zurich, Switzerland, this week, hope to create biochemical processes and then choose the gene sequences that will direct these processes and build the DNA from scratch. The scientists' goal is to select and reorder the genetic machinery developed by evolution just as an engineer might assemble an efficient circuit board from existing components.

Venter hopes to lay the basis for a new approach to synthetic biology by first synthesizing whole genomes in the laboratory and then making them take control of, or "boot up," a living cell. His new report accomplishes the second of the two steps, at least in Mycoplasma. His team, which includes a distinguished biologist, Hamilton Smith, purified the full DNA from one kind of Mycoplasma and showed that it could take control of another, making the host cell switch over to producing proteins specified by the inserted DNA. Smith said he was not sure whether the inserted genome destroyed the host genome or just made the cell divide, assigning the two genomes to different daughter cells.

Booting up cells with new genomes is a major limitation in synthetic biology, Venter said. With that hurdle now crossed, it will be possible to "design cells in future to manufacture new types of fuel and break our dependency on oil and do something about carbon dioxide going into the atmosphere."

Hood, co-founder of the Institute for Systems Biology in Seattle, said the next step on Venter's agenda, putting a functional synthetic genome into an organism, would be more significant.

"Synthesizing a whole chromosome and getting it to function will be a really remarkable step that will be much closer to the golden vision of creating new organisms," he said.

George Church, a leading systems biologist at the Massachusetts Institute of Technology, said that the new report was "good science" but that it had been achieved in an organism, Mycoplasma, that is unsuitable for industrial uses. As for Venter's assertion that his result is "an enabling technique," Church said, "The door to synthetic biology is already wide open, and people are pouring through it."

Church agreed with Venter's forecast that synthetic biologists could produce fuels within 10 years. He noted that LS9 Inc. in San Carlos, California, was producing laboratory amounts of petroleumlike fuels in bacteria.

Venter is more colorful and less publicity shy than most academic biologists. But he has many solid achievements to his credit. They have so far been in sequencing, or decoding, genomes.

He pioneered methods for sequencing the first bacterium, Haemophilus influenzae, and raced the government to a draw in sequencing a draft version of the human genome in June 2000. Though unable to produce a complete version because he was forced out of Celera, the company he headed, Venter devised a better method than his government-supported rivals, one that has become the standard way to sequence genomes.

Venter has always sought academic credit by publishing his results in scientific journals and now directs a nonprofit research laboratory in Rockville, Maryland, the J. Craig Venter Institute. But he has another foot firmly planted in the commercial world. He has set up, and the Venter Institute largely owns, Synthetic Genomics, whose goal is to make alternative fuels to oil and coal. He has also applied for far-reaching patents on the uses of synthetic life forms.

The report Thursday may be less significant if his research team is unable to repeat the success in more useful organisms than the Mycoplasma bacterium. Church said a quite similar experiment with Escherichia coli, a standard laboratory organism, was accomplished in 1958 by two French scientists, Fran�ois Jacob and E. L. Wollman.

Venter's next goal, creating the first synthetic bacterium, could have broader interest. At the Zurich meeting this week, his colleague Smith reported progress in synthesizing a Mycoplasma genome from scratch saying, according to a Nature blog, that he had already constructed it in the form of 101 long DNA fragments. When stuck together, they would comprise the whole genome.

Venter said Smith had traveled at least that far.

"We are weeks to months away from booting up that chromosome," Venter said.

The longest piece of DNA synthesized so far, he explained, is 35,000 units long, whereas the Mycoplasma genome or chromosome is 580,000 units.

The synthetic Mycoplasma, if the Venter team is successful, would be identical to the natural kind and should present no conceivable hazard. But synthetic biology is a technique with potentially far-reaching consequences like environmental effects and misappropriation by terrorists. In addition, the ability to synthesize living organisms may provoke philosophical comment.

Scientists have taken the initiative in assessing the effects with the hope of staying far enough ahead of events to avoid regulation. A report on the possible dangers of synthetic biology is being prepared for the Sloan Foundation by scientists at MIT, the Venter Institute and the Center for Strategic and International Studies.

Venter said that he was filing for many more patents and that his team was trying to scale up methods of synthesizing DNA and "watermarking chromosomes in fun ways to make it unequivocal they are manmade." He said he had no plans to use Mycoplasma as a production organism and was developing other bacteria.

"This is an area where things will happen at an exponential pace," he said. "Once people know you can do chromosomal transplants, that will trigger new approaches."

Others may already have raced ahead using old-fashion genetic engineering to put new genes into standard microbes. Steve delCardayre, vice president for research at LS9, said it had developed a strain of standard industrial microorganism that produced hydrocarbons from treated agricultural waste.

The present strain, which DelCardayre called adolescent, is "very close to meeting an economic threshold" and will be tested in a pilot plant early next year. The youthful microbe already produces an ethanol-like product, at 65 percent of the cost of corn-derived ethanol, DelCardayre said. LS9 fuels, he added, will meet the same diverse needs as petroleum does, can be transported in existing pipelines and be used in existing vehicles.

Notes:

IHT Copyright © 2009 The International Herald Tribune | www.iht.com