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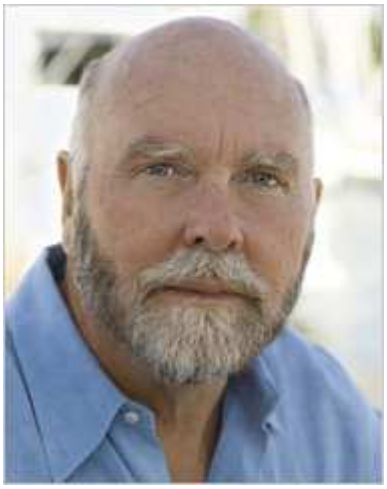
Readers' Questions: The Beginnings of Synthetic Life?



Craig Venter

Are scientists on the brink of creating entirely new forms of life? In a study published this week by the journal Science, a research team led by Dr. J. Craig Venter and Dr. John I. Glass reported that they had managed to replace the genes of one species of bacteria entirely with the genes of another. Dr. Venter and Dr. Glass will be taking readers' questions about their research and its implications on Friday, and their answers will be posted here. Submit your question below; they will not be able to answer all questions and only those selected will be published. (Editor's note: questions are no longer being accepted.)

- *Previous post* Readers' Questions: The Science of Evolution

14 Comments

1. 1. June 29, 2007 1:00 pm Link

   Are there any efforts to manufacture the rest of the cell (synthesize bacteria minus their genome)? How long do you think it will be before the machinery of the cell is understood well enough or at least measured well enough that every molecule, or at least every molecule sufficient for life, will be known?

   — *Tom*

2. 2. June 29, 2007 1:15 pm Link

   Our institute is exploring methods of making cell-like vesicles, which might serve as precursors for making some of the "hardware" components of a synthetic cell. Other labs have made semisynthetic ribosomes capable of protein synthesis. In vitro RNA transcription is a routine lab technique. At some point, someone may integrate all of these systems and produce a living cell. It is hard to say how quickly any of this can happen, because it is research and we cannot predict how and when breakthroughs happen.

In 1999 we published our first analysis of what genes in the simplest known bacterium, Mycoplasma genitalium, are essential for life. In 2006 we published a revised estimate suggesting somewhere around 400 genes were necessary for a cell to grow under laboratory conditions. A little more than 100 of those genes are still mysteries to us. We don't know what they do for the cell. It is worth noting that in nearly all of the genomes that have been decoded, that same roughly 25 percent of genes are of unknown function to scientists. Clearly this is an area that will consume many careers in science as we attempt to understand these genes and their function. It is one reason we have undertaken our work: because we believe that only by building a cell from scratch can we fully begin to understand what is essential and what are the functions and interrelationships of these proteins of unknown function in a living cell.

— Dr. Venter and Dr. Glass

3. 3. June 29, 2007 1:30 pm Link

   I wonder what is happening to the recipient cell's genome. Are you able to insert the genome into a single cell and then trace its offspring? In this case do some of the resulting cells have the original genome expressed? Does insertion somehow excite the cell to the later part of the preprophase?

   — D. Bartley

4. 4. June 29, 2007 1:45 pm Link

   We have a couple of hypotheses about the fate of the recipient-cell genome. It may sequester into a nonviable daughter cell upon the first cell division. That cell is nonviable because it lacks a tetracycline-resistance gene, and the growth medium contains that antibiotic. Alternately, the recipient-cell genome may be cut to pieces by restriction enzymes expressed from genes encoded on the donor-cell genome.

   We are working on ways to follow individual cells after initial steps in the process. For example, there are experiments under way that will allow us to follow the process using fluorescent proteins expressed by the donor cell, so that fluorescently tagged cells can be isolated using cell-sorting technology.

   — Dr. Venter and Dr. Glass

5. 5. June 29, 2007 2:00 pm Link

   Methane is so hard to capture and store. You have to seal the growth chamber and purify and compress the gas. Would it be possible to put a gene in that would make a wax instead? Then they could just have open pools that could be dredged for the wax granules every few months?

Also, the problem most algae farms have is that CO_2 is not absorbed from air fast enough, and has to be pumped in. Perhaps this could be a way to recapture power plant CO_2?

— *A. Ravikumar*

6. 6. June 29, 2007 2:15 pm Link

   One new idea in the bioenergy field is to have bacteria produce long-chain alcohols instead of ethanol or butanol. Short-chain alcohols are toxic to most cells at concentrations much above 3 to 5 percent. Long-chain alcohols are insoluble and waxlike molecules that don't affect the bacteria.

   — *Dr. Venter and Dr. Glass*

7. 7. June 29, 2007 2:20 pm Link

   I'm fascinated by the CO_2-devouring potential of reprogrammed bacteria. However, I'm also concerned about potential ecological consequences. What steps have you or will you take to ensure that they don't wreak unintended ecological havoc if they do their jobs too successfully?

   — *L. Bartram*

8. 8. June 29, 2007 2:30 pm Link

   The Venter Institute takes this concern very seriously too. We will make certain that our organisms will not be released into the environment or will not be able to survive if released by accident. We have the capacity to genetically hobble cells so that they can grow only under nonnatural conditions such as in the presence of some chemical nutrient that would have to be included in their growth medium. Current molecular-biology techniques are already enabling researchers to ensure that organisms are nonpathogenic or incapable of life outside a contained environment.

   — *Dr. Venter and Dr. Glass*

9. 9. June 29, 2007 2:45 pm Link

   Does your work have any ramifications on understanding the origin of life? In other words, what are the simplest extant life forms? Were there likely even simpler precursors now extinct? And is there any way to trace back to these early replicating organic entities?

   — *James*

10. 10. June 29, 2007 3:00 pm Link

    Potentially. From our understanding of minimal cellular function we may get hints of even simpler life forms. The mycoplasmas we work with and

whose genomes we are synthesizing are very simple cells. We know so little about the diversity of life on our planet. We would be amazed if there are not simpler forms of life somewhere. The environment could still have self-organizing pools of chemicals that are similar to the precursors of cellular life on earth. Only we don't recognize them.

— Dr. Venter and Dr. Glass

11. 11. June 29, 2007 3:10 pm Link

    Do you think that your achievement will lead to a better understanding of (a definition of the concept of) life?

    — T. Kalker

12. 12. June 29, 2007 3:25 pm Link

    We hope that it can contribute to such understanding. When thinking about synthetic life we need to have clear definitions to measure success.

    — Dr. Venter and Dr. Glass

13. 13. June 29, 2007 3:45 pm Link

    Does your work have important medical implications, and in what time frame?

    — P. Keator

14. 14. June 29, 2007 4:00 pm Link

    There are implications toward understanding how some organisms such as cholera, with two very different chromosomes, came to be and how it developed as a pathogen. In the next few years this technology might enable scientists to produce some pharmaceutical that would not be possible using chemical synthesis. Who knows how something like this will catalyze someone's imagination to create a therapeutic that we can't envision today.

    — Dr. Venter and Dr. Glass