

Language Arts Connection

Making Synthetic Cells

What is the smallest number of genes an organism needs to survive? This is the question that a group of scientists in California set out to answer when they made the first synthetic cells. Led by biologist Craig Venter, the team wanted to build a full set of genes, or genome, and 'install' it in a new cell, much like installing new software on a computer.

At first, the group sequenced the genome of a bacterium called *Mycoplasma genitalium*. This tiny microbe has the smallest genome of any known free-living organism. Its DNA holds the instructions to make only 485 proteins. The scientists then inactivated genes one at a time to determine which genes were necessary for life. As a result of these tests, the researchers proposed that 375 genes were essential for life.

To test the hypothesis that an organism could survive with only these genes, Venter and his team started building a complete genome by linking together segments of DNA. The segments of DNA were produced chemically by adding one of the four nucleotides (A, T, G, and C) to a chain of DNA in a certain order. Enzymes then linked the segments together.

The group had built a complete genome. They also included watermarks in the non-protein-coding sections of the DNA. The watermarks used the genetic code to spell out words and phrases. The watermarks also signified that the genome was synthetic and not found in nature.

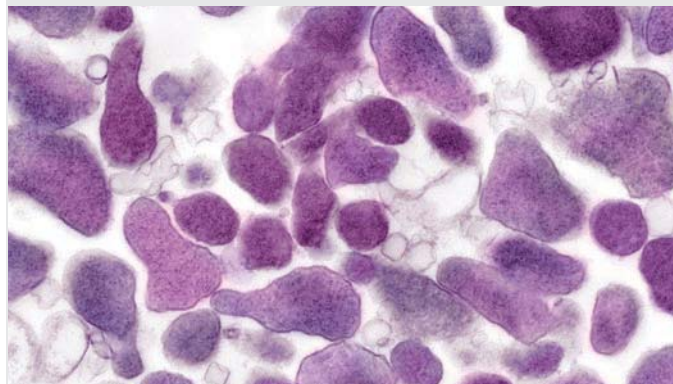
The slow growth rate of *M. genitalium* led the team to switch to a new species of bacteria called *Mycoplasma mycoides*. The scientists synthesized the new species' genome and implanted it into a different species of bacterium. They had reached their goal of making a synthetic cell. However, the genome was based on a copy of an existing genome, and it still contained more than 1 million DNA bases.

The team carried out further tests to determine the genes that were absolutely necessary for life. They mixed and matched different segments of DNA to see which combinations resulted in viable cells. This helped the researchers decide which genes to include in their design.

Venter and his group finally designed a synthetic cell called Syn3.0, which contained just 473 genes. Most of the genes with known functions were involved in expressing the DNA code. They were necessary for transcription, translation, protein folding, RNA modification, and RNA regulation. A smaller percentage were involved in DNA replication, cell division, and related functions. These genes allowed Syn3.0 to successfully replicate itself.

About a third of the genes had unknown functions. Some of these are found in other organisms like humans, and scientists hope to use Syn3.0 to study these genes and their functions. Synthetic cells could also be used to make products such as medicines and fuels. However, there are still many challenges to overcome and ethical issues to consider.

FIGURE 16: *Mycoplasma genitalium* has the smallest genome of all known free-living organisms.



Language Arts Connection Prepare for a discussion by searching for information about synthetic cells. What are some of the possibilities and concerns with using synthetic cells in research? Record evidence statements related to this question, and record the source for each statement. When you are ready, follow your teacher's guidelines for participating in the discussion. When you speak, give evidence to support your claims, and cite the sources of your evidence.



**MODELING PROTEIN SYNTHESIS
AND MUTATIONS**



**EXPLORING PROTEIN
CRYSTALLIZATION**

**Go online to choose one of
these other paths.**