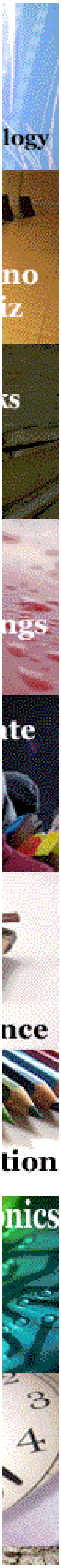

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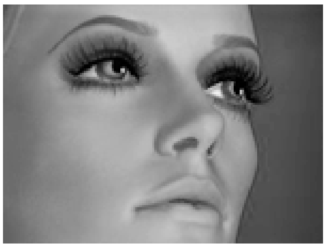

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High-powered living DNA cannon

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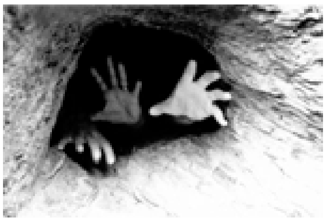

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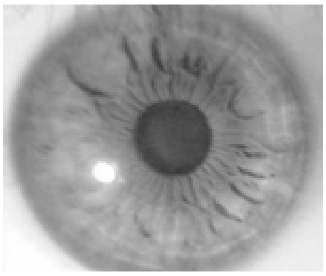


We all know that a viral infection can be developed extremely quickly, but in fact it's even more dramatic than that - the process is literally explosive.

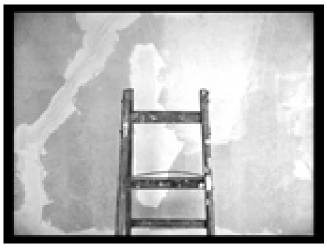
The pressure inside a virus is 40 atmospheres, and it is just waiting for an opportunity to blow up. The virus is like a living DNA cannon. How this cannon functions has been mapped by Dr. Alex Evilevitch at the Department of Biochemistry at Lund University in Sweden. This is knowledge that will have applications in gene therapy, drug development, nanotechnology and the treatment of infections. This involves a new type of virus research that is based more on physics than biochemistry. Perhaps it could be called virus biophysics. Alex Evilevitch took his doctorate at Lund in physical chemistry and worked for a few years at UCLA.

"There I met Professor William Gelbart, who predicted on theoretical grounds that the pressure in a bacteriophage - a virus that attacks bacteria - must be 40 atmospheres," explains Alex Evilevitch. "This roughly corresponds to the pressure at a depth of 400 meters under the sea. That's twenty times more than the pressure in a car tire and ten times more than the pressure in an unopened bottle of champagne. Using measurements, I was able to confirm that Professor Gelbart's prediction was accurate."

Evelevitch's research has attracted considerable attention and landed him a prize for the best research of the year in 2003 at UCLA and a 2004 Chancellor's Award at the same university. The list of recipients of the first prize includes several scientists who went on to win a Nobel Prize. But even though "virus biophysics" is a hot research field in the U.S., Evilevitch chose to return to Europe, where only a few research groups pursue such research.

"It turns out that Lund University has unique equipment for this research," says Alex Evilevitch. "At the National Center for High-Resolution Electron Microscopy there is a helium-cooled electron microscope. The cooling makes it possible to examine sensitive biological material. There are only a few electron microscopes like this in the entire world, and I had the privilege to work with it during the first months it was in regular use in research. Right now I'm busy putting together a research team in virus biophysics."

The virus that infects cells in plants, animals, and humans penetrates in its entirety into the cell and works inside. But bacteriophages are viruses that attack bacteria, working from the outside. The bacteriophage looks lik 20-faceted soccer ball with a tail, or, perhaps rather a syringe needle. It's only about 60 nanometers in size (one nanometer = a billionth of a millimeter).



But its DNA, its genetic material, is a strand that is about 17,000 nanometers long! To get it into such a small body, everything has to be packed tightly. What's more, the DNA has a negative electrical charge, which makes the tangled up strands repel each other.

When the bacteriophage comes into contact with a certain type of receptor on the surface of the bacteria cell, a canal in the tail opens and its DNA violently rushes into the cell. Once inside this DNA is reduplicated a million or more times. At the same time new protein shells are constructed for new virus particles. There is a special molecular motor that acts like a screw in its threads, rotating and pressing the DNA into the shell one bit at a time, under rising pressure. It's the most powerful molecular motor known.

Alex Evilevitch has continued to publish his research findings after his return to Lund. The latest (in Biophysical Journal, January 2005) contains measurements of the length of the DNA strands that are propelled into the bacteria. An important finding in that study is that it is a purely mechanical force, not a chemical or biological process that is at work when the virus DNA explodes.

At the moment Evilevitch is developing methods to influence the mechanical packing force in order to make it possible to squeeze more DNA into the virus capsule.

"One method used today for cloning a gene sequence is to insert it into bacteriophage DNA," says Alex Evilevitch. "After the molecular motor has worked this DNA into the virus capsule, the virus is then allowed to infect a bacteria culture. This in turn will produce millions of copies of the alien DNA. This technique is limited by the fact that there is only room for short sequences in the capsule. If it proves to be possible to influence the force needed to pack DNA, then that will enable even longer DNA strands to be pressed in. That would be a significant technological advance that would benefit future gene therapy, cloning and the general development of molecular biology."

Other ideas circulating in this new scientific field involve the use of bacteriophages as living syringe needles to inject drugs into cells. The protein casing of bacteriophages, which is strong enough to withstand the inner pressure, is also of interest to scientists. In nanotechnology the search is on for suitable packaging for carbon tubes and other nanometer-size structures.

Perhaps protein shells will provide the key to how sturdy containers can be constructed. It is also plausible to use bacteriophages in treating infected wounds, and in the U.S. trials are underway to create safer foodstuffs by controlling bacterial processes with bacteriophages.

Notes
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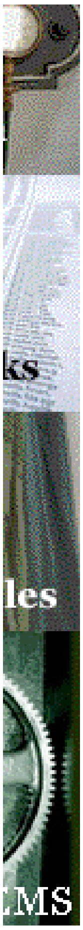
Reference URL
http://www.lu.se



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