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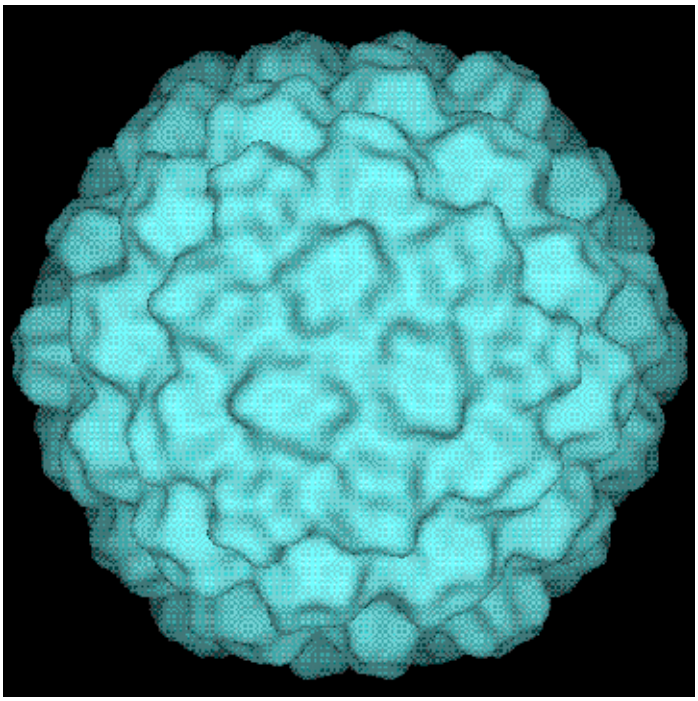
DNA Goes Ballistic

Just how viruses manage to get their DNA into a host cell has been a long-standing question in biology. Research now shows that they shoot their DNA in by keeping it under high pressure.



DNA cannon. The Lambda virus keeps its DNA under high pressure to launch it into host cells.
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Life is easy for a virus, because it tricks its host cell into doing all the work of assembling new viruses. But there is one difficult job a virus must do on its own: getting its DNA into the interior of a host cell. The cytoplasm on the inside is a thick and salty mixture of proteins and other molecules, so inserting a DNA molecule is like trying to squeeze a line of people into an already crowded subway car.

To see if viruses might shoot their DNA into cells by keeping it under pressure, Alex Evilevitch, a molecular biologist at the University of California, Los Angeles, and colleagues designed a pressure test. First they put the Lambda virus--a DNA virus that lives off *Escherichia coli* bacteria--into solutions containing the *E. coli* membrane protein that triggers Lambda to eject its DNA. They also mixed in increasing

concentrations of an inert organic polymer to ramp up the osmotic pressure, up to the point where the virus couldn't completely eject its genome. By quantifying the DNA remaining inside viruses at various pressures, they were able to determine how hard Lamda pushes, and thus estimate its internal pressure.

The results, published online this week in the *Proceedings of the National Academy of Sciences,* reveal Lambda to be a DNA cannon, keeping its interior at about 40 times atmospheric pressure, roughly 10 times more pressurized than a champagne bottle. The pressure is caused by the strong intermolecular forces of the DNA bent up within the virus's protein walls. The results match theoretical models of how much pressure Lambda needs to exert on its DNA to launch into a cell's interior after docking. The method can be used to measure the pressures within other viruses, including those that use RNA instead of DNA, says Evilevitch, and should prove useful for researchers hoping to redesign viruses as drug-delivery devices.

Jonathan Widom, a molecular biologist at Northwestern University in Evanston, Illinois, finds the results convincing, describing their experimental approach to viral ballistics as "so elegant."

--JOHN BOHANNON

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