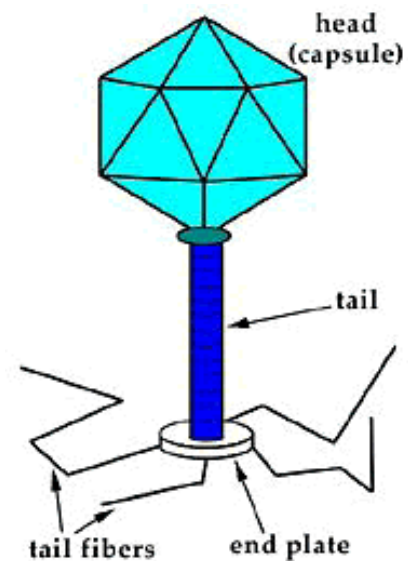


Read these observations about a virus, called a bacteriophage, that infects bacteria.

When it comes into contact with a host cell, a virus can insert its genetic material into its host, literally taking over the host's functions. An infected cell produces more viral protein and genetic material instead of its usual products. Some viruses may remain dormant inside host cells for long periods, causing no obvious change in their host cells (a stage known as the lysogenic phase). But when a dormant virus is stimulated, it enters the lytic phase: new viruses are formed, self-assemble, and burst out of the host cell, killing the cell and going on to infect other cells. The diagram below shows a virus that attacks bacteria, known as the lambda

bacteriophage, which measures roughly 200 nanometers. This is 0.000000002 of a meter or 0.0002 of a millimeter.

Viruses cause a number of diseases in eukaryotes. In humans, smallpox, the common cold, chickenpox, influenza, shingles, herpes, polio, rabies, Ebola, hanta fever, and AIDS are examples of viral diseases. Even some types of cancer -- though definitely not all -- have been linked to viruses. Viruses themselves have no fossil record, but it is quite possible that they have left traces in the history of life. It has been hypothesized that viruses may be responsible for some of the extinctions seen in the fossil record (Emiliani, 1993). It was once thought by some that outbreaks of viral disease might have been responsible for mass extinctions, such as the extinction of the dinosaurs and other life forms. This theory is hard to test but seems unlikely, since a given virus can typically cause disease only in one species or in a group of related species. Even a hypothetical virus that could infect and kill all dinosaurs, 65 million years ago, could not have infected the ammonites or foraminifera that also went extinct at the same time.



On the other hand, because viruses can transfer genetic material between different species of host, they are extensively used in genetic engineering. Viruses also carry out natural "genetic engineering": a virus may incorporate some genetic material from its host as it is replicating, and transfer this genetic information to a new host, even to a host unrelated to the previous host. This is known as transduction, and in some cases it may serve as a means of evolutionary change -- although it is not clear how important an evolutionary mechanism transduction actually is. [<http://www.ucmp.berkeley.edu/allife/virus.html>]

In 2013, a study published in Nature reported that a viral predator (a virus) of the cholera bacteria has stolen the functional immune system of the bacteria and is using it against its bacterial host. The study provides the first evidence that this type of virus, the bacteriophage ("phage" for short), can acquire a wholly functional and adaptive immune system that it can then pass onto the next generation of phages.

[<http://now.tufts.edu/news-releases/new-study-shows-viruses-can-have-immune-syste#sthash.iUDgoQx.dpuf>]

To sum up, a bacteriophage:

- Contains genetic material
- Reproduces only when inside another organism
- Has an outer case made of protein
- Injects genetic material into a bacterial cell
- Uses the energy and the structure of the bacterial cell to make parts that assemble into copies of itself (and often kills the bacterial cell).
- Can change its genetic material

You many have noticed that neither the video segment, “A Diversity of Organisms” nor the essay, *Three Domains*, contained any reference to viruses. Yet we often think about viruses in relation to life. For example, have you ever heard someone complain about being *attacked* by a virus? Scientists today are debating the question “Is the bacteriophage alive?” **Use your knowledge of the unifying principles of life** to construct a well-reasoned argument to answer the question, “Is the bacteriophage alive?”

A well-reasoned argument will provide **evidence** to back up any inferences or conclusions that you make. Underline any evidence you include in your answer.