

Sputnik Mimivirus Mamavirus
Part I: Defining "life"



According to a study appearing in *Nature* (1), researchers have discovered the first virus to infect another virus. It was found in a cooling tower inside a strain of the viral giant, mimivirus. The mimivirus was first isolated in 1992 from amoebae growing in a water tower in England (2). Mimivirus primarily infects amoeba although antibodies to the virus have been found in some cases of human pneumonia (see *The Clinical Newsletter*, January 2009).

The researchers describe a new strain even larger than mimivirus, which they named mamavirus. While examining the new strain they saw a smaller virus attached to mamavirus. It was named Sputnik (“traveling companion” in Russian).

Sputnik infects the replication machinery in mamavirus and causes it to produce deformed viral structures. It has a similar effect on mimivirus. Because Sputnik's behavior so closely resembles what bacteriophage do to bacteria, the researchers called the new type of virus a virophage, and suspect it may represent a new virus family.

Both the particle size and the genome size of mimivirus is larger than that of some small bacteria. The genome provides sufficient information to allow the virus to perform most, but not quite all, of the functions of living cells. The complexity and magnitude of the mimivirus genome, combined with the large size of the virus, calls into question some of the established divisions between viruses and single-celled organisms, as well as raising questions about their evolution and what constitutes a living organism.

Mimivirus possesses many characteristics which place it at the boundary of living and non-living. It is as large as several bacterial species, such as *Rickettsia conorii* and *Tropheryma whipplei*, possesses a genome of comparable size to several bacteria and codes for products previously not thought to be encoded by viruses. In addition, mimivirus possesses genes coding for nucleotide and amino acid synthesis, which even some small obligate intracellular bacteria lack. Mimivirus is, therefore, not dependent on the host cell genome for coding several metabolic pathways. They do, however, lack genes for ribosomal proteins, making mimivirus dependent for protein translation and energy metabolism. These factors combined have thrown scientists into debate over whether mimivirus is a distinct form of life. Nevertheless, mimivirus does not exhibit the following characteristics, all of which are part of many conventional definitions of life: homeostasis, response to stimuli, growth in the normal sense of the term (instead replicating via self-assembly of individual components) or undergoing cellular division.

Because its lineage is very old and could have emerged prior to cellular organisms, mimivirus has added to the debate over the origins of life. Some genes unique to mimivirus, including those coding for the capsid, have been conserved in a variety of viruses which infect organisms from all domains. This has been used to suggest that mimivirus is related to a type of DNA virus that emerged before



cellular organisms and played a key role in the development of all life on Earth. An alternative hypothesis is that there were three distinct types of DNA viruses that were involved in generating the three known domains of life - Eukarya, Archaea and Bacteria.

So, is mimivirus alive? Is it an obligate parasite as is the case with some human pathogens? Like all viruses, mimivirus particles do not reproduce by division, but are replicated by the self-assembly of preformed components. This differentiates it from cellular living organisms such as bacteria. And yet, it can be “infected” by another virus.

References

1. Nature 455:100 (2008)
2. Science 299:2033 (2003)

Part II, Proving pathogenic potential, will appear in the January 2009 issue of *The Clinical Newsletter*.