What Is a Virus and What Makes Them Both Fearsome and Useful?

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Even people who are in the best of health occasionally battle the common cold or the flu — both caused by viruses. In the case of the common cold, the rhinovirus is most often the culprit. In the case of the flu, it’s the various permutations of the influenza virus. And those are just two types in a panoply of viruses that inhabit our world, including polio, rabies, Zika and Ebola.

But what exactly is a virus? How is it different from bacteria? And how can a microbe that is believed to be one of the most primitive organisms on our planet wreak so much havoc with our bodies? Read on to find out what makes viruses both fearsome and useful.

The Basics

A virus is essentially a bundle of genetic code, either in the form of DNA or RNA, encased in a protein coating, known as a capsid. But, unlike bacteria, a virus cannot reproduce itself without invading a host cell because it lacks some of the crucial machinery for metabolism and replication.

Because of this, there has been much debate over whether viruses are really “living” — and even the rules for what makes a virus a species, and where they come from, are slightly atypical. For example, while species of plants, animals, or bacteria are typically grouped according to physical and genetic traits, virus “species” (there are over 3,600) may also be grouped together according to the type of host they replicate in.

A Mimivirus particle imaged with electron microscopy. The 1992 discovery of this virus — the largest and most complex virus discovered to date — showed that this virus came remarkably close to crossing the threshold into being able to replicate itself without a host cell. (Photo credit: Ghigo E, et al)

The Fearsome

Whether it’s a rhinovirus that causes the common cold or a virus that causes a more fearsome disease such as Ebola, the mechanism is similar. When a virus comes into contact with a host cell, it inserts its genetic material into the host, triggering the infected cell to reproduce the virus’ genetic material and proteins. Those reproduced viruses then burst out of the infected cell and spread to other cells.

In the case of Ebola, the virus inhibits interferon, a signaling protein that normally curtails the spread of pathogens. And as the virus spreads throughout the body, it can trigger one of the most horrifying symptoms of Ebola — hemorrhaging. And coming into contact with these bodily fluids can transmit the virus to others.

Viruses achieve all of this despite their miniscule size — anywhere from 10 to 100 times smaller than bacteria, and only recently visible at a high resolution.

The Useful

Despite the ability of some viruses to wreak havoc on our health, that same ability to deliver genetic material into host cells has become an invaluable tool. In fact, many viruses don’t affect humans or aren’t pathogenic — that is, they don’t cause a disease.

Some of those non-pathogenic viruses such as the adeno-associated virus (AAV) have become an important tool in understanding how the human genome works and in exploring and implementing gene therapy because of the ability of a virus to get their host cells to replicate their DNA or RNA.

That property — the very property that makes pathogenic viruses so problematic for their host — is now being used in gene therapy by utilizing viruses as vectors to carry healthy genes to swap out defective ones. AAV is unique in that it belongs to a group of viruses that require the presence of a “helper” virus to cause infection. For that reason, AAV has not been shown to cause diseases in humans.

So, while it’s true that viruses are the cause of many illnesses, our growing knowledge about them and how they replicate has also opened the door to using the properties of these microbes to heal.

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