

Viruses: The Invisible Enemy Revealed

Dorothy H Crawford

Professor of Medical Microbiology and Assistant Principal for Public Understanding of
Medicine

University of Edinburgh, UK

Viruses are tiny sub-microscopic entities whose structure was only elucidated after the invention of the electron microscope in the 1930s. We now know that viruses are by far the most abundant life form on Earth. Recent estimates suggest that there are in excess of $\sim 5 \times 10^{30}$ of them on the planet, that they are ubiquitous and staggeringly diverse. With around 100 million different types, they occupy every available niche including such inhospitable abodes as hot water springs, deep ocean trenches, the polar ice caps and acid lakes. One litre of sea water contains around a billion of them and in total the Earth's viruses lined up side by side would stretch across six galaxies.

Viruses, unlike any other life form, are not composed of cells but are particles consisting simply of a protein shell surrounding a piece of genetic material – either DNA or RNA. With no mechanisms for generating energy or making proteins, these particles are inert until they enter a living cell. Only then do they come to life and hijack the cell's machinery to produce thousands of daughter viruses. The smallest viruses have just three genes (compared to our $\sim 20,000$) but still they can infect, reproduce and spread in a matter of hours, sometimes causing life-threatening diseases. Clearly this minimalist lifestyle is highly successful.

All viruses are parasites but they have evolved remarkably varied and highly sophisticated survival strategies. Those that cause acute infections have perfected the technique of reproducing rapidly and moving on before they are wiped out by the host's immunity, whereas others have a more leisurely lifestyle. These have learnt to hide from their host's immune mechanisms and setup a persistent infection.

Rhinovirus, the common cold virus, causes an acute illness by infecting the cells lining the nose. Here it has learnt to tickle local nerve endings causing excess mucus secretion and sneezing, so projecting an aerosol spray of virus-laden mucus droplets into the atmosphere to maximise its spread. Aerosol spread works best among crowds and so the virus has evolved to cause symptoms mild enough to keep infected hosts up and about, travelling in packed trains and sitting in crowded classrooms.

The chicken pox virus also generally causes mild symptoms when it first infects. But this is a herpes virus, a family which are adept at spreading in sparse populations. The virus puts its energy into hiding in nerve cells, away from its host's immune system so that it can lodge for life in the same individual. It only reappears in old age to cause the painful rash of shingles and also to spread to younger family members who have not yet met the virus.