What is a Virus?

This is the transcript of an interview with Dr Michael McGarvey by LBC Radio (based in London) which was broadcast on 16 May 2001.

LBC - What is a virus?

MMcG - Viruses are one of the main classes of microscopic agents which cause infectious disease. Fundamentally, they are parasites which contain a genetic programme that allows them to take over the normal functions of the cells that they invade and to force the cells to make new copies of the virus.

A virus is mainly made from protein which provides protection for its genetic programme which is itself contained in a DNA or more commonly RNA molecule - RNA is in many way related to DNA. I think that it is important for me to try to distinguish between viruses and bacteria, which can also cause infectious diseases, as they are frequently confused. Surprisingly, scientific and medical correspondents of even the "serious press" quite frequently add to this confusion by using the terms "virus" and "bacteria" almost interchangeably.

Viruses and bacteria are completely different in their structure and the way they reproduce and it is actually very important to clearly distinguish between them, not just for scientists studying them, but more importantly because treatments for bacterial and viral infections are quite different. Antibiotics for example, which can be used to treat many bacterial infections have no effect on viruses. Bacteria are free living cells, that contain a couple of 1000 genes. They carry out a large number of biochemical reactions, they make their own proteins and have their own energy supplies. Viruses on the other hand have far fewer genes, with the average virus having about 10 to 15 genes, though some more complex viruses have up to one to two hundred genes. They don't carry out any biochemical reactions themselves but instead they are totally dependant on the cells, which they invade, for example to produce the proteins that go to make new viruses. And once a virus has been released from a cell it is quite inert – until it encounters a new cell that it is able to infect.

LBC - What does a virus look like?

MMcG - Viruses are very small, much smaller than cells. To get some idea of their relative sizes, imagine, if the average cell in your body was say, the size of the Millennium Dome, then the average virus would then be about the size of a human being. So powerful electron microscopes, which can magnify by about 100,000 times are needed to study viruses. Viruses come in a variety of shapes and sizes, some look like round blobs, some are elongated and tube like, though the most common shape – which many different viruses have is a bit like an old world war two sea mine. You know the shape, a sphere with rods sticking out from it! However unlike a mine, when a virus bumps into a

cell, it doesn't explode, instead, it sticks to it. The rods on its surface are like little hooks or magnets that attach the virus to the cell and by doing so the virus can then get inside the cell.

LBC - What kind of diseases and illnesses are caused by viruses?

MMcG - Viruses are responsible for many diseases that we are probably all familiar with. The common cold, mumps, chickenpox, cold sores and warts are not particularly pleasant but don't usually cause serious problems. More serious viral diseases include, influenza, polio, rabies and smallpox (though smallpox is no longer the terrible disease it once was since it was eradicated almost a quarter of a century ago).

Viruses cause long term diseases which can be life threatening, for example HIV seriously damages or destroys the immune system, hepatitis B and hepatitis C viruses can severely damage and eventually destroy the liver. Some viruses have an important role in causing certain cancers, for example infection with some human papilloma viruses has been strongly linked to cervical cancer and hepatitis B and hepatitis C virus infections are strongly associated with liver cancer.

LBC - How do they enter our bodies and cause infection?

MMcG - Well there are several ways that viruses can enter our bodies Through the air we breathe, as in the old saying, "coughs and sneezes spread diseases" – examples of this would be the common cold and influenza viruses. Contaminated drinking water or shellfish grown in dirty water can spread hepatitis A virus and viruses that cause diarrhoea (diarrhoeal viruses are a serious health care problem in third world countries, particularly for young children). Sexual contact can transmit HIV, hepatitis B virus and human papilloma virus. HIV, hepatitis B and hepatitis C viruses can also be spread by blood either by blood transfusions or blood products (though there is little risk of this in most developed countries today) and by the sharing of needles by users who inject themselves with drugs.

LBC - How are viruses detected?

Virus infections often trigger a response by the immune system and antibodies are produced which are specific for a particular virus. These antibodies can often indicate that a virus infection has occurred or is still occurring and special tests have been designed to specifically detect these antibodies. Similar tests can also detect some of the proteins that make up the outer structure of a virus that is present in the blood. More sophisticated tests, based on the detection of virus genetic material are also used and these can often give an indication of the quantity of virus present – which can be helpful in determining whether a particular form of treatment may be effective.

LBC - How can we treat viruses?

MMcG - Vaccines which prevent infections are the first line of defence against a number of the important viruses, for example, measles, mumps, rubella, polio, hepatitis B and influenza. However there are no vaccines for important viruses such as HIV and hepatitis C – there is of course a great deal of interest in trying to develop vaccines against these viruses, but it is not an easy task. The second approach to treatment is the use of antiviral drugs. Although there has recently been an increase in the number of such drugs available for example that inhibit HIV, there are still very few, antiviral drugs for most infections and far fewer than the number of antibiotics that can be used against bacteria.

LBC - Why do viruses such as HIV become resistant to drugs?

MMcG - Well, the reason is, in one word, evolution. Viruses reproduce and evolve at an enormous rate. When a virus infects a single cell it can often produce many thousands of copies of itself in 24 hours. So an antiviral drug which might stop 99.9% of a particular virus from growing would still allow many viruses (from a single cell) to escape its effects. So after a few generations, most viruses would be resistant and eventually only drug resistant viruses would be present – in other words the drugs would perform what might be called artificial evolution to produce resistant viruses. To try to slow down this enormous rate of virus evolution, two or three drugs are now used to treat HIV (so-called combination therapy). This makes it much more difficult, but not impossible, for the virus to evolve this kind of resistance.

LBC - What are the main future concerns about viruses?

MMcG - One worry is that established viruses might spread from one part of the world to another due to human population movements or climate changes and bring new populations into contact with virus diseases that they had not previously been exposed to. An important example of this is dengue virus, which cause, haemorragic disease in humans, and which currently is spreading from tropical regions of the world to Australia, North America and perhaps even southern Europe. There is also the danger that new viruses will be transmitted from animals to humans.

Many of the viruses that cause diseases in humans probably originated in animals. For example, influenza, measles and smallpox. HIV appears to be descended from a virus that, more recently, jumped from a species of chimpanzee to humans. There are also several viruses that have in the past couple of decades causes a series of local outbreaks with a high mortality rate in man. Examples of these are the Ebola virus in Africa and hanta virus in the United States and Korea. The dangers are that these viruses which appear to come from infected animals will adapt themselves to humans as a host and then spread to large population centres.

Finally, to combat the different virus diseases that I have mentioned requires long term research both for vaccines (for example against HIV and hepatitis C virus) and antiviral drugs. This requires the mutual cooperation of university and industry based research. And also in the longer term it will probably be necessary to develop new therapies. Examples of these might be gene therapy or new classes of designer virus inhibitors.