WHAT PIRBRIGHT IS DOING

Livestock vaccines

Scientists are developing several different vaccines that will protect livestock from zoonoses, and so help prevent these animals from transmitting the viruses to humans.

We are collaborating internationally to produce an inexpensive, safe and effective vaccine to protect pigs against Nipah.

To combat CCHF, researchers are conducting a series of field studies to test whether a vaccine developed by Public Health England prevents infection in sheep, to get a better understanding of the disease dynamics and get reliable estimates of the virus prevalence in the unvaccinated population to inform the vaccine trial.

Scientists are also developing a new universal vaccine to protect against all strains of influenza virus. This is extremely challenging due to the number of strains of flu virus circulating and the emergence of new strains. Currently we are testing an S-FLU aerosol vaccine, developed by Alain Townsend at Oxford. The pig immune and respiratory systems are very similar to humans so may provide a better model for infection and vaccination studies.

Vector control

Mosquitoes carry and transmit many deadly diseases that result in millions of deaths.

We are studying the ability of European mosquitoes to transmit RVF virus as well as understanding how susceptible European livestock breeds are to the disease. This will reveal how big a threat RVF poses in Europe and enable us to predict how an outbreak may spread.

We are also exploring ways in which genetically modified (GM) mosquitoes could be used to control populations and help prevent the spread of zoonoses. Modifying male *Aedes* mosquitoes to produce sterile offspring enables targeted suppression of the population. These methods could be employed to tackle a variety of insect borne diseases such as RVF, Zika and malaria. We use the latest GM techniques for controlling mosquito-spread diseases, including CRISPR/Cas9 and gene drives that only control populations locally.

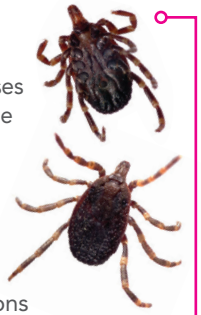
Aedes aegypti female feeding

Predicting new threats

Predicting where the next virus will emerge from, or how an existing virus might mutate to transmit between animals or humans more efficiently, is a crucial part of disease control.

Pirbright scientists use complex mathematical modelling incorporating data from the Met Office to investigate how weather patterns influence the movement and transmission of diseases. This provides valuable insight into how some airborne diseases may interact with the atmosphere and the movement of vectors that transmit disease.

The role of climate change



Rising temperatures across Europe are one of the driving forces that allows diseases to travel further north from southern Europe and Africa. The insect vectors that carry these diseases are then able to survive at higher latitudes for longer, increasing their ability to spread disease.

Hyalomma ticks, the vector for CCHF, are highly adapted to warm and dry conditions and if these conditions become more widespread populations of these ticks are likely to become established, bringing with them the risk of CCHF to humans.

UK ticks are unable to transmit CCHF to humans, but a changing climate could increase the risk of *Hyalomma* ticks moving and living further north. Migratory birds and horses can transport the tick into new areas and by 2080 the conditions may be warm enough for them to survive in the UK.

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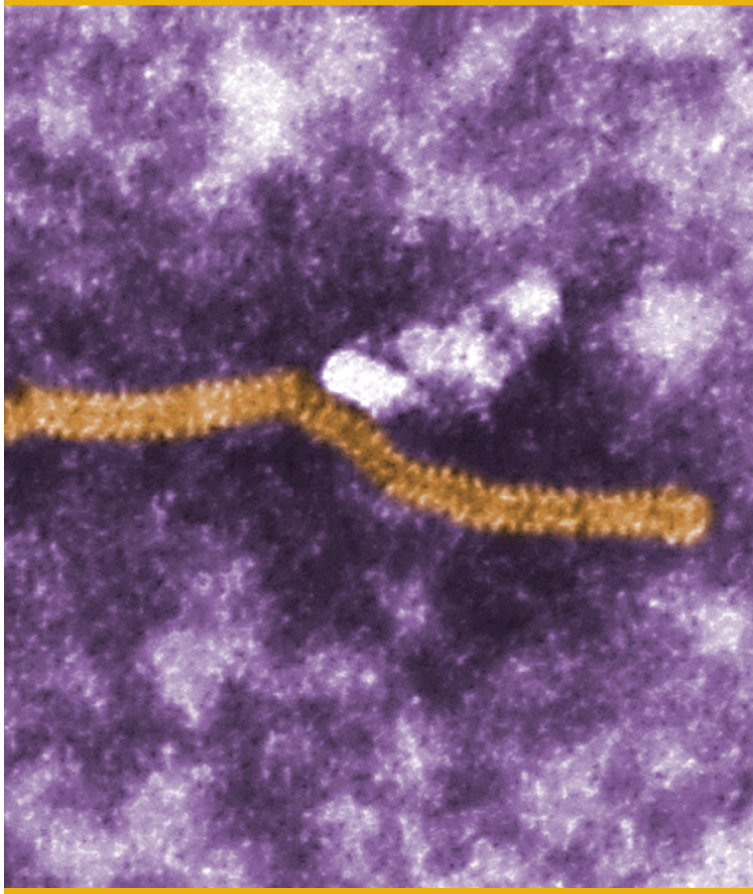
www.pirbright.ac.uk/zoonoses

ZOONOTIC DISEASES

Viruses that spread from animals to people



THE Pirbright INSTITUTE

Preventing and controlling viral disease

ZOONOTIC DISEASES – KEY FACTS

Zoonotic diseases are infections caused by viruses, bacteria and parasites that spread between animals and people. They can make people and animals very sick, and can be fatal. Pirbright scientists study viral zoonotic diseases to try and find ways to stop them spreading.

Scientists estimate that 6 out of 10 human infectious diseases come from animals, and 3 out of 4 new infectious diseases are spread from animals to people. With increased global movement of people and animals and human activity close to animal habitats, controlling and predicting diseases is a priority.

Viral zoonoses are spread directly through contact with saliva, blood, urine or other bodily fluids of an infected animal, by airborne means (influenza) or indirectly (vector borne) via bites from a tick or an insect, for example such as a flea or mosquito (Zika).

In 2018 the World Health Organization (WHO) released a list of priority diseases based on their potential to become pandemic and the lack of robust control measures. All ten diseases on the list are caused by viral zoonoses. These include viruses like Crimean-Congo haemorrhagic fever (CCHF), Ebola, Nipah, Rift Valley fever, Zika and Disease X.

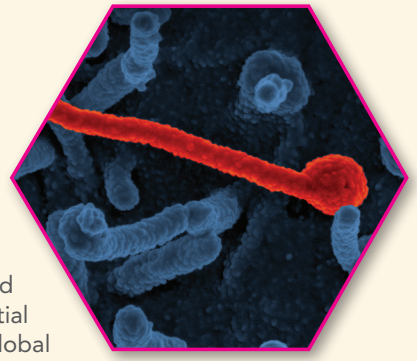
WHAT ARE VIRAL ZOONOSES?

Zoonoses affect a wide range of species and have a huge impact on animal and human health, as well as food and economic security. At Pirbright we study viral zoonoses, the insects that spread these diseases (known as vectors) and we develop vaccines to control them.

Some zoonoses have re-emerged to cause epidemics resulting in widespread suffering and global concern. Most recent examples include the 2013 outbreak of Ebola virus disease which spread throughout West Africa until it was successfully controlled in 2016 – over 11,000 people died as a result. Ebola has since re-emerged in the Democratic Republic of Congo.

Another zoonosis which is transmitted by infected mosquitoes (*Aedes*) is Zika virus which, although causes only mild symptoms in the majority of people, can cause microcephaly in foetuses and result in Guillain-Barré syndrome, neuropathy and myelitis in children and adults.

Rift Valley fever, Nipah, severe acute respiratory syndrome (SARS), and avian and swine influenza viruses are also examples of viral zoonoses that have either caused or have the potential to cause serious global pandemics and they continue to pose a threat.



Scanning electron micrograph of Ebola virus Makona (in red) from the West African epidemic shown on the surface of Vero cells (blue).

Credit: NIAID

MAKING THE LEAP

Health experts and scientists worry that the next global pandemic could be caused by a new or re-emerging zoonosis.

Zoonoses are often transferred from animal to human by a change in the genetic structure of the virus, for example both SARS and Middle East respiratory syndrome (MERS) coronaviruses are thought to have been caused by a genetic mutation that enabled them to jump species. Changes in environment, climate and geography can also play a part – deforestation destroys areas leading to once remote habitats being invaded by humans who are then more likely to be exposed to new infections. However, it is often unclear why some diseases mutate into deadly viruses and each new threat poses further challenges for science and public health.

CONTROLLING ZOONOSES

It takes time and money to develop vaccines to control new diseases therefore resources are targeted at those diseases that have the potential to spread rapidly causing severe infections. Affected countries also work together to scan for new outbreaks, track the spread and use this data to map zoonotic diseases and inform control strategies.

PIRBRIGHT'S RESEARCH

Our scientists study a range of viral zoonoses:

- Crimean-Congo haemorrhagic fever (CCHF) infects both wild and domestic animals, such as cattle, sheep and goats, and humans. Infection is caused by a bite from an infected tick (*Hyalomma*) or being exposed to the blood or fluids of infected animals or humans. 10-40% of people who develop haemorrhagic fever after infection are likely to die from the disease.
- Rift Valley fever (RFV) affects sheep, cattle and goats. It is transmitted by mosquitoes but it can also be spread through direct contact with infected animals and meat. In severe cases, the human fatality rate may be 10-20%.
- Avian influenza viruses (bird flu) have a natural reservoir in wild birds such as ducks. The H5N1 and H7N9 strains can cause severe disease and have a high mortality rate in people.
- Swine influenza viruses infect a wide range of animals, but are most commonly present in pigs. In 2009 the H1N1 strain caused a global outbreak in humans killing over 18,000 people.
- Nipah virus has a mortality rate of up to 40% in people. Fruit bats are the natural reservoir but it also infects pigs, which are more likely to spread the disease to humans. Transmission of Nipah virus between humans, pigs and bats is through direct contact with excretions like bat urine.
- Chikungunya virus is mosquito borne and found in monkeys, birds, cattle, and rodents but it also infects people. Symptoms include a short fever followed by severe joint pains that can persist for years.