Epidemics and Immunity

'The course of human history has been shaped as much by microbes as by politicians, soldiers and great thinkers,' wrote Susan Aldridge in *Magic Molecules* (1998). And she wasn't referring to biological weapons. She goes on to point out that the Second World War was the first major conflict in which epidemics took *fewer* casualties than battle.

The scale of the problem

In 1997 about 50 million people died worldwide. Around 17 million of these people died because of infectious and parasitic diseases – things like cholera and malaria. About 10 million of them were under five years old. Two million of these 10 million deaths, it is estimated, could have been prevented if existing vaccines had been available.

If we separate the figures between developed and developing countries there are striking differences. Levels of hygiene, housing, nutrition, and education as well as vaccination programmes and medical care hugely affect the spread and severity of infectious diseases.

The germ theory of disease

For quite some time people weren't really sure about how and why somebody became ill. It wasn't until the beginning of the 20th century that people understood that certain germs caused certain diseases.

This was largely thanks to work during the previous two centuries: Edward Jenner injected himself with the cow-pox virus to build immunity against the deadly scourge of smallpox at the end of the 18th century, Louis Pasteur developed vaccines for anthrax and rabies, and Robert Koch created the Koch's postulates – a test to prove that a particular disease was caused by a specific germ – in the 19th century.

Gradually, as the causes of different diseases and the way they were spread was understood, stricter hygiene and, in some cases, control of the insect vectors – malaria-carrying mosquitoes, for example – was able to help limit outbreaks.

Vaccines were developed for tuberculosis (TB), diphtheria and tetanus in the 1920s; polio, measles and rubella (German measles) in the 1950-60s; and vaccines for whooping cough, mumps, cholera, typhoid and some forms of meningitis, hepatitis and influenza have been developed more recently.

The second half of the 20th century saw the widespread expansion of public health vaccination programmes and the development of a selection of life-saving antibiotic drugs to treat bacterial infections.

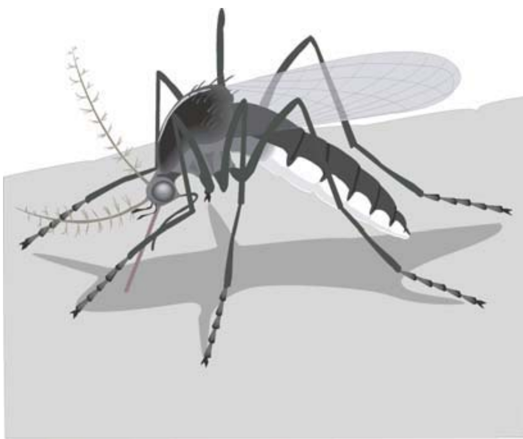
Pathogenic organisms

Infectious diseases are caused by microbes – organisms too small to see with the naked eye. Human-disease-causing organisms include bacteria, viruses, fungi and protozoa.

Transferring microbes directly from one person to another can spread some diseases (the sexually transmitted ones are obvious examples). Others are transmitted only after passing through another organism. For example, malaria only spreads from person to person after the parasite has passed through a

Worldwide vaccination

The World Health Organisation has promoted and co-ordinated vaccination programs throughout the world since it was created in 1948 with the aim of getting a high level of health for all people. One of its many achievements is that eight out of ten of the world's children are now protected against six major childhood diseases – diphtheria, whooping cough, tetanus, measles, tuberculosis and polio.



mosquito vector.

A new class of infective materials, prions, have recently been associated with mad cow disease and the human form, varient CJD. Prions consist only of protein and are not organisms in the sense that they have no genetic material (DNA or RNA).

Immunity through vaccination

When Edward Jenner found that infection with cowpox gave immunity to the much more serious disease of smallpox, he was exploiting the natural process of fighting off infections. It worked because during infection with cowpox the immune system produces special antibodies that trigger the destruction of the infecting microbes. When the same or, in the case of smallpox, a similar enough microbe is encountered again the immune system, having eliminated it before, can trigger that destruction much more quickly.

Vaccine production

The stimulus for the immune system, known as an antigen, is usually a protein on the surface of the microbe. There are now several different ways of producing antigens for vaccines. Some vaccines are based on live but attenuated (weakened) microbes, others on dead microbe material. A few are based on the toxins (poisons) that are produced by the microbes. The toxins are chemically altered in a way that means they are no longer toxic but will still act as antigens. Some organisms that cause disease are difficult to grow outside the body and modern genetic engineering techniques are being used to produce the antigenic proteins using specially modified microbes that are easily grown in bulk.

This method of stimulating the immune system does not work for all viral infections and it is hoped that another type of vaccine under development, which uses DNA, will work by stimulating a different part of the immune system. Other difficulties arise with viruses such as the flu virus, which can change its outer coat. Previous infection or vaccination only gives protection against some strains of the virus, so that the flu virus regularly causes new epidemics.

The next step

When smallpox was eradicated in the 1970s it seemed as if many infectious diseases might be conquered with global vaccination campaigns. Good progress has been made with many diseases but new epidemics have occurred. It was not foreseen that about 30 new disease-causing microbes would be identified in the last quarter of the 20th century or that multi-drug resistant forms of existing diseases would have so much impact. Breakdown of public health measures in some countries due to political and economic factors, increasing urbanisation and global travel, together with the threat of biological weapons mean that on a world-wide scale the fight against infectious diseases will continue to need a high priority well into the twenty first century.

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What you need to do:

Write an essay considering the factors that have influenced disease epidemics in the 20th century with particular reference to the development of immunisation programmes. This could be approached from a historical or a geographical perspective.

Your teacher will provide you with a selection of background information. This will include information about:

- Infectious diseases; their causes and methods of transmission.
- Death rates (and causes) for relevant periods and areas.
- Public health initiatives (UK or world-wide), particularly immunisation campaigns.
- The development and production of vaccines (from both scientific and economic points of view).

Resources that might help you:

Aldridge, Susan. Magic Molecules: how drugs work. 1998 ISBN 0-521-58414-0

Howe, G. Melvyn. People, Environment, Disease and Death: a medical geography of Britain throughout the ages. 1997 ISBN 0-7083-1373-6

Karlen, Arno. Plague's Progress: a social history of man and disease. 1995 ISBN 0-575-06135-9

Kiple, Kenneth F. (Ed.) Plague, Pox and Pestilence 1997 ISBN 0-75380-712-2

www.immunisation.org.uk

www.vaccinealliance.org

www.who.int (the World Health Organisation, some of the data is difficult to use)

www.prb.org (the Population Reference Bureau, includes population data for school use)

www.wellcome.ac.uk (includes information about their History of Medicine Library)

www.iob.org (the Institute of Biology, includes factsheets on TB and biological weapons)

If you want to go further:

Look at the development of antibiotics and their impact on health and life expectancy from either a historical or geographic perspective.