Introducing the germ experts:

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Isabel Thomas read Human Sciences at Oxford University and has written more than 150 books for children and young adults, winning the *AAAS Subaru Prize for Excellence in Science Books* 2020. Her books have also been shortlisted for the English 4–11 *Picture Book Awards*, the *Royal Society Young People's Book Prize*, *The ASE Science Book of the Year*, and the *Blue Peter Best Book With Facts*.



CONSULTANT

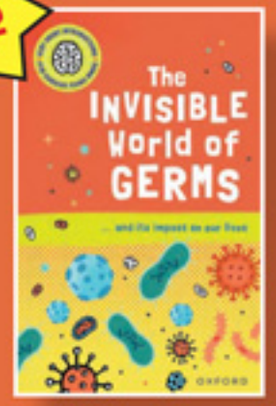
PROFESSOR ALAN RADFORD



Alan Radford teaches virology at the University of Liverpool. His main research interests are the genetic diversity and evolution of pathogens, especially viruses, and the germs of pet animals, and how they occasionally may affect humans. He is particularly interested in how they evolve and are transmitted within populations. He established a national disease surveillance network called SAVSNET, which aims to better understand pet animal disease in the UK.

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The Invisible World of Germs explores how we discovered that germs cause infections and disease, the science behind diseases, and the ways we have developed to live alongside germs.

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Chapter 1

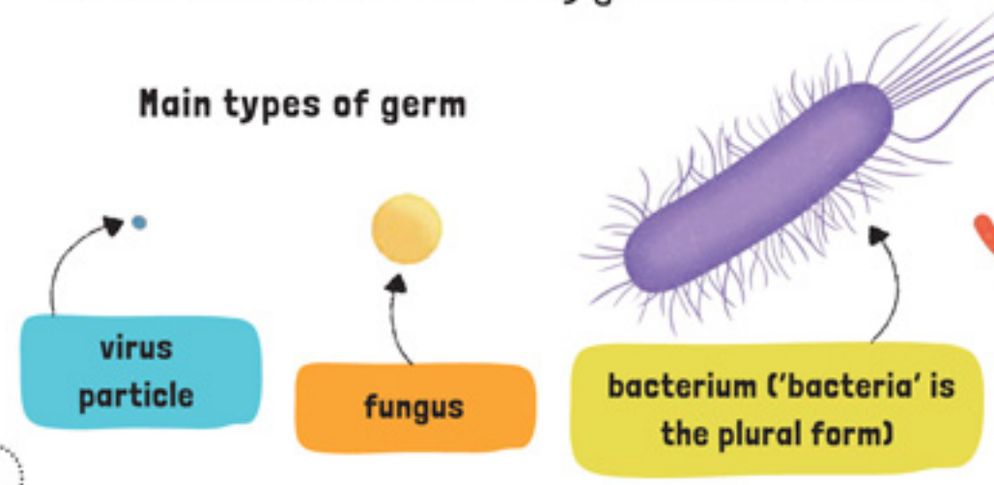
What Are Germs?

Wherever you go on Earth—from the highest mountain to the driest desert to the deepest, darkest ocean trenches—you will always be surrounded by living things too tiny to see. They are known as microbes. Like all living things, microbes spend their time feeding, getting rid of waste, and reproducing.

Some **microbes** can cause harm when they go about their lives on or inside our bodies. We call these harmful microbes 'germs', and describe them as '**pathogenic**'.

People also use the word 'germs' to describe viruses, which are even smaller than microbes. Viruses don't have all the features of living things, but some of them can cause harm when they get inside our bodies.

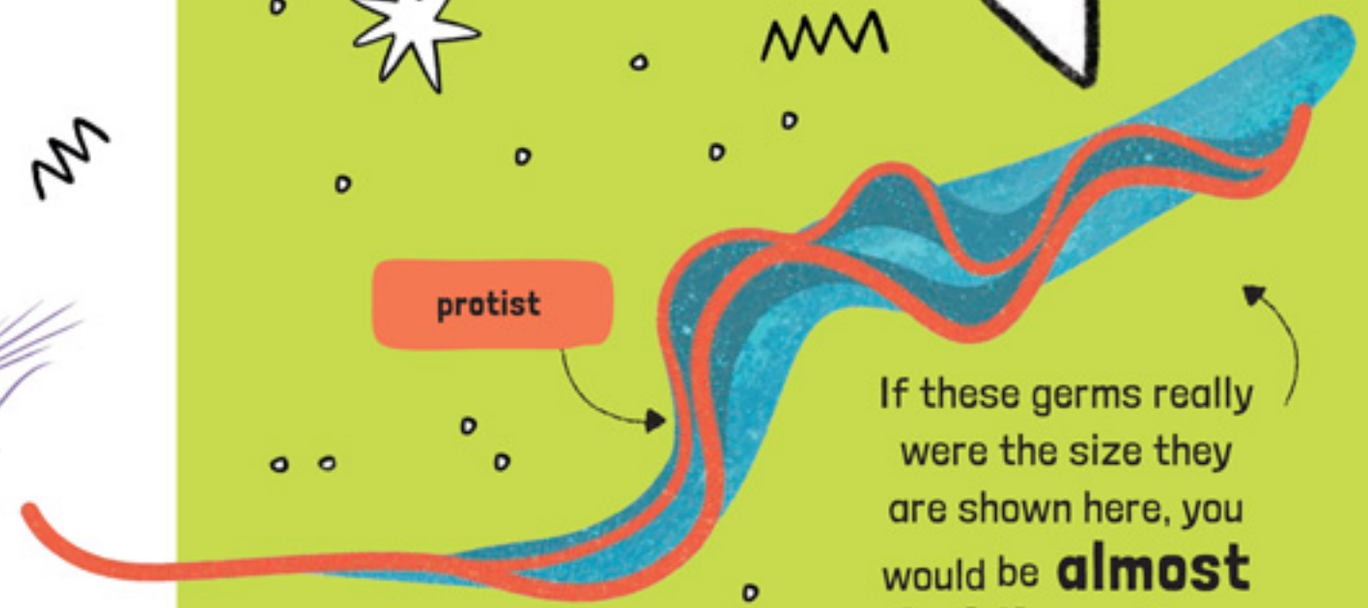
Main types of germ



Speak like a scientist

MICROBE

'Micro' means very small, and microbes are the smallest living things. They are so tiny that a single square centimetre of your skin—your fingertip, say—can be home to millions of microbes, but you'll never see them! Most microbes can only be seen with the help of a microscope that can magnify them tens, hundreds, thousands, or even millions of times.



If these germs really were the size they are shown here, you would be **almost six kilometres tall** in comparison!

Deadly travellers

War and **trade** spread many more diseases besides bubonic plague (and still do). Some of the most terrible **epidemics** (widespread outbreaks of disease) in history were caused by European explorers travelling to the Americas in the 15th and 16th centuries. They brought smallpox, a horrible infectious disease that spread quickly among Native Americans, including the people of the Aztec and Incan Empires.

The Native Americans had never been exposed to smallpox before—or other nasty European diseases such as measles and mumps. They had no natural immunity (see page 55). After just fifty years, more than 25 million Native Americans had died.



Seeds of disease

At the time, only one person suspected the true cause of these devastating epidemics: an Italian doctor and poet called Girolamo Fracastoro. He came up with the idea that **contagious** diseases were caused by tiny 'seeds' that could multiply quickly. He said they could be transferred from an infected person to other people in three ways—direct contact, on objects such as dirty clothes, or through the air.

This was a **really good** description of germs! But Fracastoro's theory of 1564 didn't catch on, until someone actually saw one of these 'seeds' for the first time.

Following the Middle Ages, Europe exploded with new ideas and inventions, including discoveries about the human body. But it was the invention of the microscope that led to a breakthrough in understanding the cause of infections and infectious diseases.

The first microscopes made objects look around ten times bigger, but by the late 1600s, Antonie van Leeuwenhoek was handmaking microscopes that could magnify objects 200 times.

GERM HERO

ANTONIE VAN LEEUWENHOEK

The first person to see microbes and suggest they could be the cause of infectious diseases.



Now he could explore a hidden world beyond his natural senses—and **he was hooked!** Van Leeuwenhoek looked at everything from a **spider's bottom** to a **gnat's eye.**



Protists

Protists are the third type of microbes that can also be germs—and are the most varied group of living things. They feed, move, live, and reproduce in thousands of different ways.

Although most protists are made up of just one cell, they are more like plants or animals than bacteria. Many have tails or hairs to help them move around. Some build hard shells. Others can make their own food using the energy in sunlight. Some even cluster together to make bigger living organisms, such as slime moulds that creep along the ground, gobbling up bacteria!



This species is known as **dog vomit slime mould.**

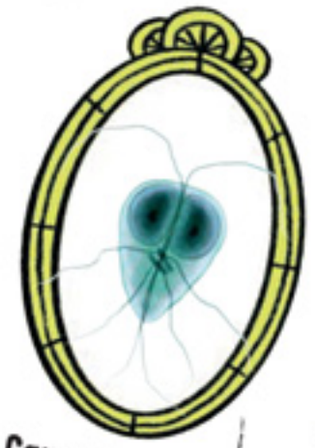
That is GROSSLY unfair!

Protists do have one thing in common: they all like to live in watery habitats, including inside plants and animals. Some are parasites that cause plant diseases and damage crops.

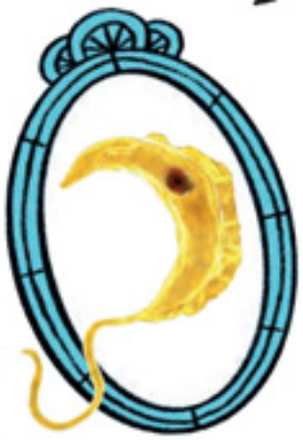
DISEASES CAUSED BY PROTISTS



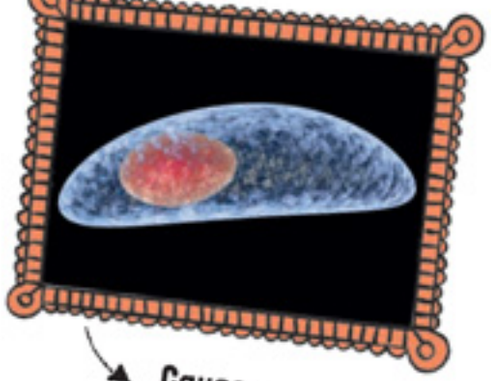
Causes MALARIA



Causes GIARDIASIS



Causes SLEEPING SICKNESS



Causes TOXOPLASMOSIS

Malaria is one of the world's deadliest diseases. It is caused by a type of protist called plasmodium. Instead of reproducing by simply splitting in two (as bacteria do), they have **very complicated life cycles,** which involve infecting two different animals: humans and mosquitoes.

Chapter 8

The Future of Germs

Germs are here to stay but so is science. Here are some of the questions that scientists are hoping to answer in the future.

Will there be more pandemics and new diseases?

Although microbiologists were not surprised by Covid-19, many people were. In some countries, people had got used to living without major epidemics of infectious disease thanks to vaccines and antimicrobials. But the way humans live makes outbreaks inevitable. There will be new diseases, and they will most likely be **zoonoses**. We interact with animals on farms, in markets, in science, in the wild, and as pets. Almost three quarters of all new human infectious diseases in the past thirty years began as germs in animals.

But not every zoonosis becomes an epidemic or pandemic. We can **stop this happening** by learning from the past, taking steps to prevent outbreaks, and acting quickly when they do occur. We can demand that our governments fund research into new antimicrobials and vaccines, act to improve living conditions, and make sure that everyone, no matter how much their family earns, can access healthcare.

