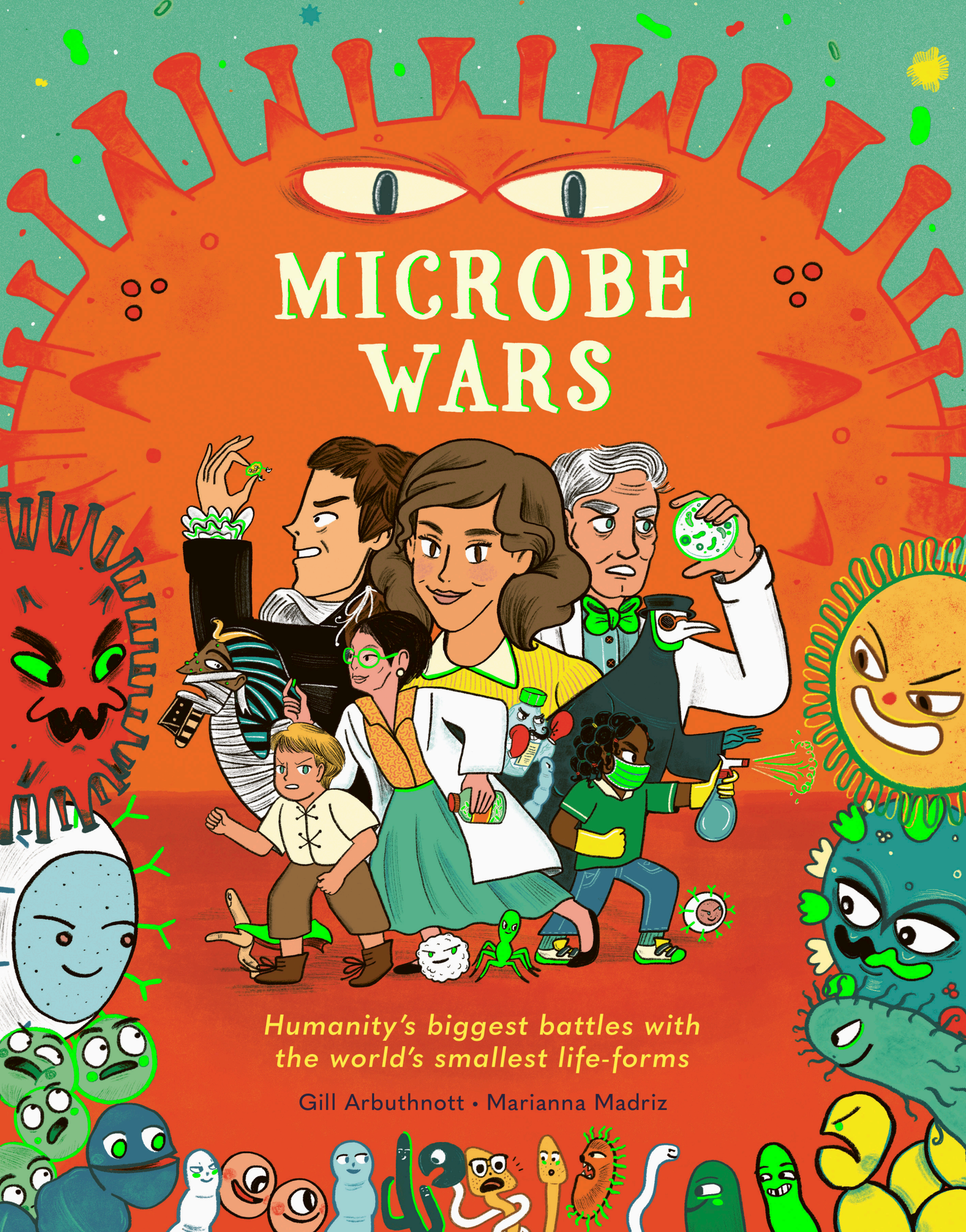
MICROBE WARS



Humanity's biggest battles with the world's smallest life-forms

Gill Arbuthnott • Marianna Madriz

MEET MORE MICROBES

You didn't think that was all of them, did you? The show goes on! These are the real A-Listers; you've probably heard about some before, or seen others on TV. But you wouldn't want to see them *all* performing live...

BACTERIA

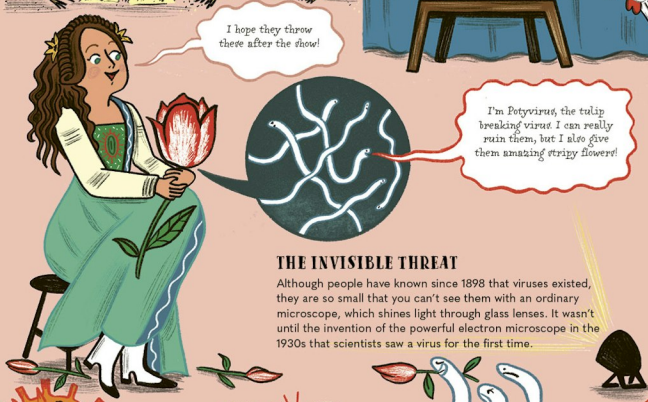
All the world's a stage for bacteria: these single cells are found almost everywhere, including your skin and guts! In fact, you have at least as many bacteria cells in your body as human cells – so who's really in charge? Some bacteria make their own food, while many feed like fungi. Luckily, most bacteria are harmless or even super helpful, but others live as parasites in other living things and these can cause diseases like sore throats and food poisoning.

HERO OR VILLAIN?

Clostridium botulinum bacteria live in soil, but occasionally gets into damaged tins of food. This bacteria makes the most toxic substance of any living thing – botulinum **toxin**. Less than 100 grams of it could kill everyone in the world, and people inject it into their faces! If you make it very dilute, it's called Botox and smooths out skin wrinkles, and can also help patients with chronic pain.

VIRUSES

Viruses aren't alive. They aren't even cells. They're just bits of **DNA** or **RNA** with instructions for making – you guessed it – more viruses, all wrapped up in protein and sometimes fat. They hijack cells, breaking in and making them produce more viruses. This damages the cells and causes diseases like flu and Covid-19. Viruses attack every living thing: even bacteria!



THE INVISIBLE THREAT

Although people have known since 1898 that viruses existed, they are so small that you can't see them with an ordinary microscope, which shines light through glass lenses. It wasn't until the invention of the powerful electron microscope in the 1930s that scientists saw a virus for the first time.

THE BLACK DEATH

You've probably heard of the plague, one of the scariest sicknesses in human history, but do you know the full story?

In 1347, trading ships arrived in Sicily. Many of the sailors were dead or dying. The 'death ships' had brought Black Death (sometimes called plague) from Asia to Europe. It killed between a quarter and a third of Europe's population, then went very quiet from 1770.

When you sang 'Ring a ring o' roses', I bet you didn't know you were singing about *that!* The *'ring o' roses'* rash and *'atishoo'* sneezing were early symptoms. The *'pocket full of posies'* was because people thought sniffing a bunch of flowers or herbs would protect them (it didn't).

LONDON BURNING!

The Great Fire of London in 1665 began in a bakery in Pudding Lane, in the midst of a plague outbreak that had killed one in seven Londoners. The flames destroyed most of the city, but it did destroy enough of the germs to end the wave of sickness.

SIGNS AND SYMPTOMS

The disease sometimes started with the rash and sneezing, then you would develop painful lumps called **buboes** in your armpits and groin and purple spots on your skin. The lumps, which were full of bacteria, turned black (hence the name) and if they burst, you were doomed...

THE PLAGUE VILLAGE

In September 1665, fleas in a bale of cloth that had been sent to the Derbyshire village of Eyam from London started to bite people. Those people started to die of plague.

Somehow, the village rector, William Mompesson, persuaded most of the villagers to quarantine themselves, so they wouldn't spread plague to other towns. No one went in or out of Eyam. By November 1666, when the outbreak ended, 260 villagers had died, out of a population of fewer than 800, but their sacrifice had saved hundreds of other people.

200 YEARS OF HIDE & SEEK

A WEISS DECISION

Before the mid-19th century, no one knew what caused infections like sepsis (blood poisoning from bacteria), so no one knew how to prevent them. This made hospitals incredibly dangerous. Doctors carrying out operations just wore their normal clothes, maybe an apron to catch bloodstains, walked from patient to patient and stuck their dirty hands straight in!

In 1847 a Hungarian doctor, Ignaz Semmelweiss, started making medical students wash their hands after examining corpses. The death rate from infections in his hospital dropped from eighteen percent to one percent, but it still didn't catch on. Finally, in 1864 a French scientist, Louis Pasteur, proved that bacteria and viruses caused infections, and hospitals finally turned hygienic! You'll hear more about him in a minute...

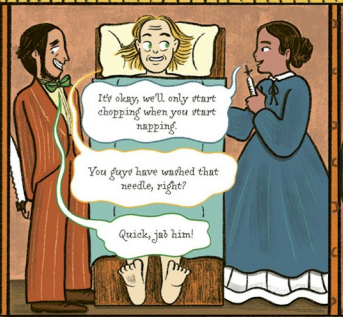
SNOW VS. WATER

In the 19th century, people thought cholera was caused by miasma (bad air). But when John Snow (1813–1858) traced an outbreak in London to a public water pump, he found evidence that microbes in the water were behind it all! When the pump was closed, cholera cases fell sharply.

NOTHING GETS PAST PASTEUR

Louis Pasteur (1822–95) studied **fermentation** (the process that produces wine — see p. 43) and why wine spoiled, and he believed that it was all down to microbes. He discovered you could avoid wine spoiling by heating it up between 60 and 100 Celsius, killing the microbes off! Nowadays **pasteurisation** is used worldwide to destroy microbes in milk, fruit juice and beer.

But how did he prove Semmelweiss right? Well, Pasteur also developed vaccines which would only have worked if Semelweiss' theories were correct. In 1881 he developed one against anthrax bacteria, and in 1885 he was working on one against the rabies virus, and tested it when nine-year-old Joseph Meister faced certain death after being mauled by a rabid dog. Luckily, the vaccine worked, saving Joseph's life.



LISTER'S LAST RESORT

Even with basic hygiene and **anaesthetics**, surgery was very risky. Surgeon Joseph Lister (1827–1912) knew about Pasteur's work and finally went to war with microbes, cleaning surgical instruments, wounds, and even surgeons' hands with carbolic acid. Lister's **antisepsis** system has saved countless lives.

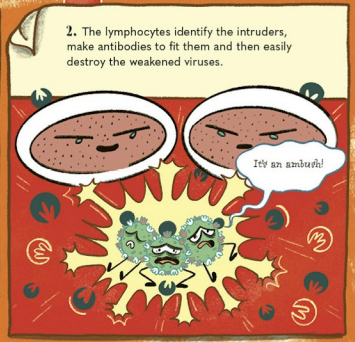
Now surgery is carried out in **aseptic** conditions, by cleaning the room with **antiseptics**, filtering the air, heating up surgical instruments — and always washing hands!

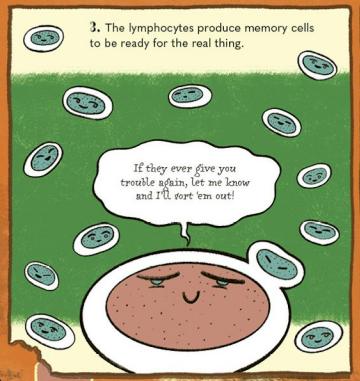
FAR-FLUNG FRIEDMANN

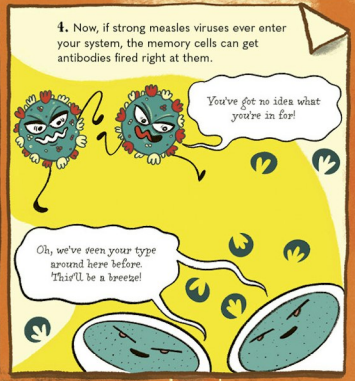
Roseli Ocampo-Friedmann (1937–2005) was a Filipino-American scientist who wanted to find out how tough microbes are, and the extreme conditions they might be able to survive. She discovered microbes in areas presumed to be totally lifeless like the deserts of Antarctica, where Friedmann Peak has been named in her honour. Her work has even been used by NASA to theorise about microbes on Mars!

HOW VACCINATION WORKS

Immunisation is the effect of a succesful vaccination. It tricks your immune system into making memory cells without you getting ill first. You're injected with a tiny dose of a bacteria or virus that has been killed or weakened. Vaccines cannot hurt you, but they still have antigens, so the immune system leaps into action. Let's try it with measles...



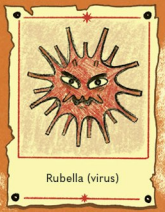





Polio (virus)

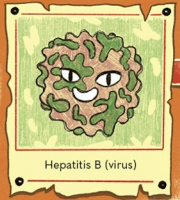
Tetanus (bacteria)

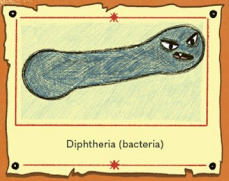

Measles (virus)

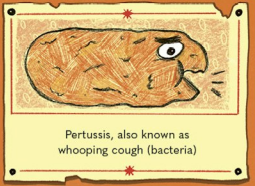

Rubella (virus)

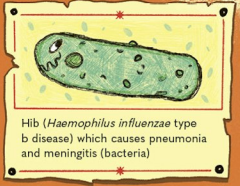
Immunisation programmes now exist in every country in the world, and vaccines have saved millions of lives by protecting us against polio, diphtheria, tetanus, pertussis, measles, the Hib virus, rubella, hepatitis B and more.

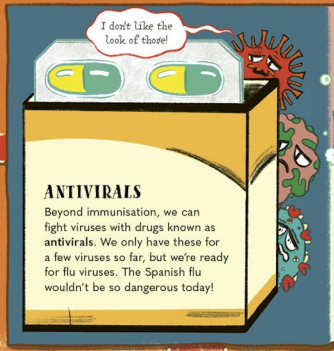
Still, we're always on the look-out for the worst offenders!


Hepatitis B (virus)


Diphtheria (bacteria)


Pertussis, also known as whooping cough (bacteria)


Hib (*Haemophilus influenzae* type b disease) which causes pneumonia and meningitis (bacteria)



ANTIVIRALS

Beyond immunisation, we can fight viruses with drugs known as **antivirals**. We only have these for a few viruses so far, but we're ready for flu viruses. The Spanish flu wouldn't be so dangerous today!

WHAT ABOUT NEW VIRUSES?

For new viruses, like COVID-19 (see p. 20), the effects can be disastrous if it's never infected humans before and spreads rapidly. After all, nobody has memory cells for a new virus, and we certainly don't have vaccines. We can only stave the virus off with antivirals and treatments to help with symptoms while scientists run to the labs!