## Rosemary

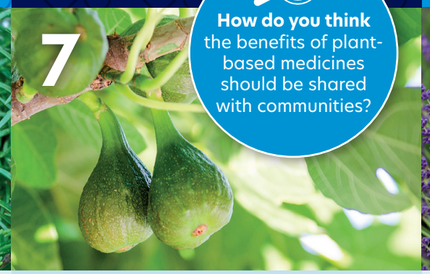

**Should** governments help scientists discover new antibiotics? If so, how?

### Antimicrobial resistance, innovation, and promising plants

The golden age of antimicrobial discovery ended in the 1980s, and it has become harder to find new antimicrobials. All the while, our existing stock is stopping working against some bugs. But the quest continues! Scientists are going back to their roots (literally!) and are, once again, looking to plants for new antimicrobials. The study of **ethnobotany** looks at relationships between humans and plants, especially indigenous knowledge of the benefits of some plants.

According to some lab studies, **rosemary** (*Salvia rosmarinus*) might act against *Staphylococcus aureus*. If it worked in hospital settings, this could have a big impact, as there are sometimes **multidrug-resistant** strains of *S. aureus* (MRSA) that are very difficult to treat.

## Fig




**How do you think** the benefits of plant-based medicines should be shared with communities?

### Changing land use and climate

As we turn to **ethnobotanical research** and to traditional medicine to address AMR, we should think about the possible effects. There could be a big increase in demand for some plants with antimicrobial properties, meaning more cultivation. This **changing land use** can infringe on forests or cause local communities to effectively lose access to newly expensive plants. Deforestation and medical insecurities are more concerning given worsening climate change.

**Figs** (*Ficus carica*) have been used in traditional medicine to treat open wounds and digestive conditions in European traditional medicine. Dried fig may work against bacteria from the lower gut that can cause disease, according to some lab studies.

## Lavender


**What might be important** when it comes to the future of AMR?

### Toward a sustainable microbial future

In some ways, we don't yet know where we should be or where we want to end up with AMR. We don't know what plant antimicrobials can offer in terms of innovation, because most of them have not been properly tested in humans. One thing is for sure: we should aim for a sustainable future where humans, animals, the environment and even microbes can be in the right balance.

**Lavender** (*Lavandula angustifolia*), like nearly all plants, both relies on and needs to control microbes it interacts with. A fungus that grows on lavender roots helps them grow further, to reach deeper water. But the flowers contain 300 different secondary metabolites that help them control other microbes. We, too, need to take care of helpful microbes but avoid harmful ones.

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**The Ethox Centre** engages with ethical questions presented by climate change, global health and the development of new technologies.


1. **Japanese Bitter Orange** *Citrus trifoliata*
2. **Ginkgo** *Ginkgo biloba*
3. **Century Plant** *Agave americana*
4. **Aloe Vera** *Aloe vera*
5. **Apple** *Malus domestica*
6. **Rosemary** *Salvia rosmarinus*
7. **Fig** *Ficus carica*
8. **Lavender** *Lavandula angustifolia*

# Plant Power!

## Stop the superbugs


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## Introduction

Our world is full of **microbes**, like **bacteria, viruses, and fungi**. Most of these microbes are harmless, but others cause disease in humans, animals, or crops. We use **antimicrobial drugs** like antibiotics to stop these harmful microbes. But the bugs are resisting. **Antimicrobial resistance (AMR)** is where microbes evolve into **superbugs** that antimicrobials can't stop or kill. Because AMR is a natural process, we can't stop it entirely. But we do need to do more to treat diseases caused by microbes, prevent infection, and have healthy animals and crops.

On this trail, you can learn about how plant antimicrobials have been used historically, how they're promising new potential medicines, and what we should do to stop the superbugs.

**Keep an eye out for this symbol for Spotlight on the Ethics questions.**

For discussion about the questions and to learn more as you go through each stop, **scan here** →

**Please do not pick or consume any of the plants on the trail.**

*This trail does not make any therapeutic claims about the effectiveness of plant-derived antimicrobials.*

## Japanese Bitter Orange


### Plants as medicine

Plants compete for space, sunlight, water, and nutrients against other plants, but also fungi, parasites, and other living things. To do this, they produce **secondary metabolites**, which give them their smells, tastes, and colours. These are often antimicrobials, protecting the plant from infection.

For example, **Japanese bitter orange** (*Citrus trifoliata*) contains the bitter chemical poncirin.

**Do you think** it's bad for plants to kill microbes?

Poncirin may help plants to grow faster. Studies on poncirin show it may reduce inflammation, treat allergies, and change our gut bacteria, which changes how we digest food.

## Ginkgo


**Do you think** we should hope to live in a microbe-free world?

### Antimicrobial resistance and evolution

**Antimicrobial resistance (AMR)** is when a microbe doesn't die or stop growing when treated with antimicrobials. Resistance is evidence of **evolution**. The idea is that whenever living things are exposed to harsh conditions—like bacteria exposed to an antimicrobial drug—most will die, but a few might survive. The survivors reproduce, and pass drug resistance down to the next generation.

*Ginkgo biloba* is a tree native to China that's been around since the time of the dinosaurs! Over millions of years Ginkgo has evolved to have proteins in its seeds that prevent slimy bacterial 'biofilm' build-up that would otherwise block nutrient absorption.

## Century plant


### Opportunity for infection

**How much** should we rely on knowledge of antimicrobials from traditional medicine?

Some of the same microbes that harm plants can also harm humans. For example, if we have an open wound we might get microbes in the wound, which are usually harmless but can cause illness. We call these **opportunistic pathogens**.

In traditional medicine practices from around the world, plant roots, leaves, seeds or flowers are used as pastes or teas to try to treat common diseases. The leaves of the **century plant** (*Agave americana)* can stop the growth of the bacteria that cause typhoid fever, in lab studies. Lots of plant antimicrobials seem to work in lab settings, but working in humans is a whole different question. Each antimicrobial requires thorough research.

## Aloe vera


**Should we** be held responsible for stopping the spread of disease?

### Antimicrobials, mummies, and historical texts

Plant antimicrobial use (whether deliberate or accidental!) is described from ancient times. Hippocrates, the famous Greek physician, mentions medicinal plants as long ago as 500 BCE. The Bible and the Islamic Sunna of the Prophet have shed light on plants that were used for health. Before the late 19th century, people didn't understand that germs can cause disease, so it's unlikely that plant antimicrobials were understood scientifically. But some religious food requirements may have health benefits that relate to stopping the growth of harmful microbes on meats.

**Aloe** has been used since ancient times, for example in embalming bodies of the dead in Egypt. It was thought that preventing their bodies from decomposing gave the spirit eternal life.

## Apple


**How do you think** antimicrobials should be used in medicine, and how might you help?

### New medicines

The **antimicrobial era** started with discovery of the first antimicrobials in the early 1900s.

Penicillin is the most famous, discovered by Sir Alexander Fleming in 1928. It was part of a revolution in medicine against specific disease-causing microbes. There were some good reasons for the switch from plant antimicrobials to man-made, **pharmaceutical** antimicrobials. Many plants have toxins harmful to humans, even if they have other useful properties. Pharmaceutical antimicrobials only contain the single, desired chemical.

You might have heard the saying, "an apple a day keeps the doctor away." This wisdom doesn't come from nowhere! Antimicrobials in **apples** could use the mechanism of stopping bacterial cell walls from forming.