

ONLY UP:

BEAT THE BUG

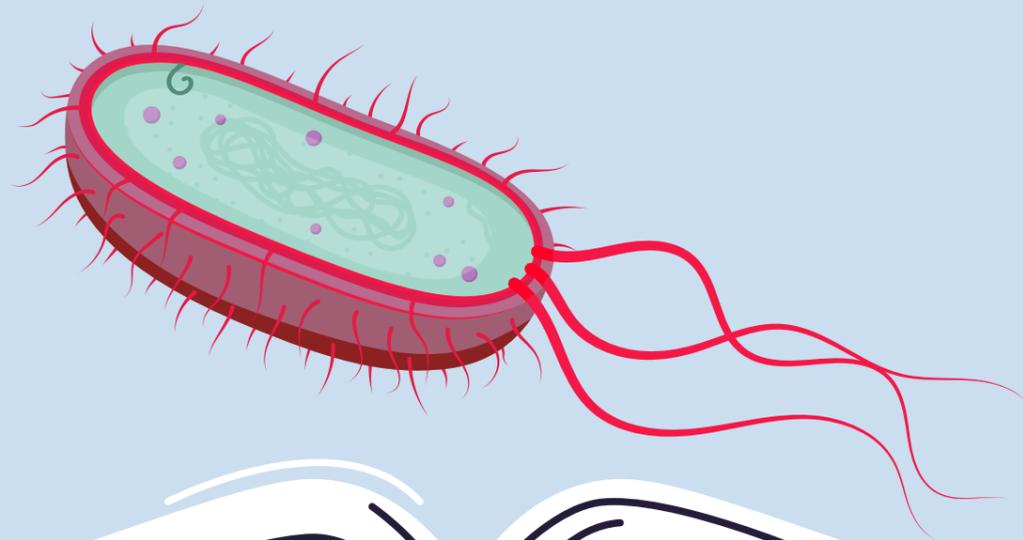
LESSON 1



LESSON 1

UNDERSTANDING ANTIMICROBIAL RESISTANCE: ATTACK AND DEFENCE

This lesson plan, the first of three, presents the critical issue of Antimicrobial Resistance (AMR). It explores its potential implications on health and economies, and engages students in preventive measures, including responsible antibiotic use, hygiene, and vaccination.



LESSON 1

Opens by exploring the world of microbes and the microbiome, explaining their roles in health and disease. Students learn the differences between bacteria and viruses and the illnesses each can cause, with a focus on the importance of maintaining a healthy gut microbiome. They get an overview of how antibiotics work and why they are crucial in treating bacterial infections, along with the consequences of misuse and overuse in humans and animals, leading to resistant strains of bacteria.

This lesson introduces the One Health Approach, highlighting the interconnectedness of human, animal, and environmental health and emphasises antimicrobial resistance as a global cross-border challenge requiring coordinated efforts across various

sectors. Interactive activities and discussions encourage critical thinking about combating antimicrobial resistance, advocating for responsible antibiotic use, and recognising the importance of hygiene and vaccination.

By understanding these core topics, students gain foundational knowledge essential for grasping the complexities of antimicrobial resistance. This lesson plan will equip them with the critical thinking and skills to address one of the most pressing public health challenges of our time, setting the stage for deeper exploration in subsequent lessons.

LESSON INTRODUCTION

AMR: THE SUPERBUGS FIGHTING BACK!

IMAGINE A WORLD WHERE MEDICINE STOPS WORKING

Ouch! Sounds scary, right? Well, that's exactly what antimicrobial resistance (AMR) is all about. Basically, microorganisms (those tiny, sometimes harmful things that make us sick) are developing super-powers that make them resistant to antimicrobials (the medicine that usually zaps them). This means infections become harder to treat, leading to longer illnesses (including higher healthcare costs), and even death (!!!).

Antimicrobial resistance is a BIG problem; It is estimated that more than 35 000 people die each year in the EU/EEA as a direct consequence of an infection due to bacteria resistant to antibiotics. The

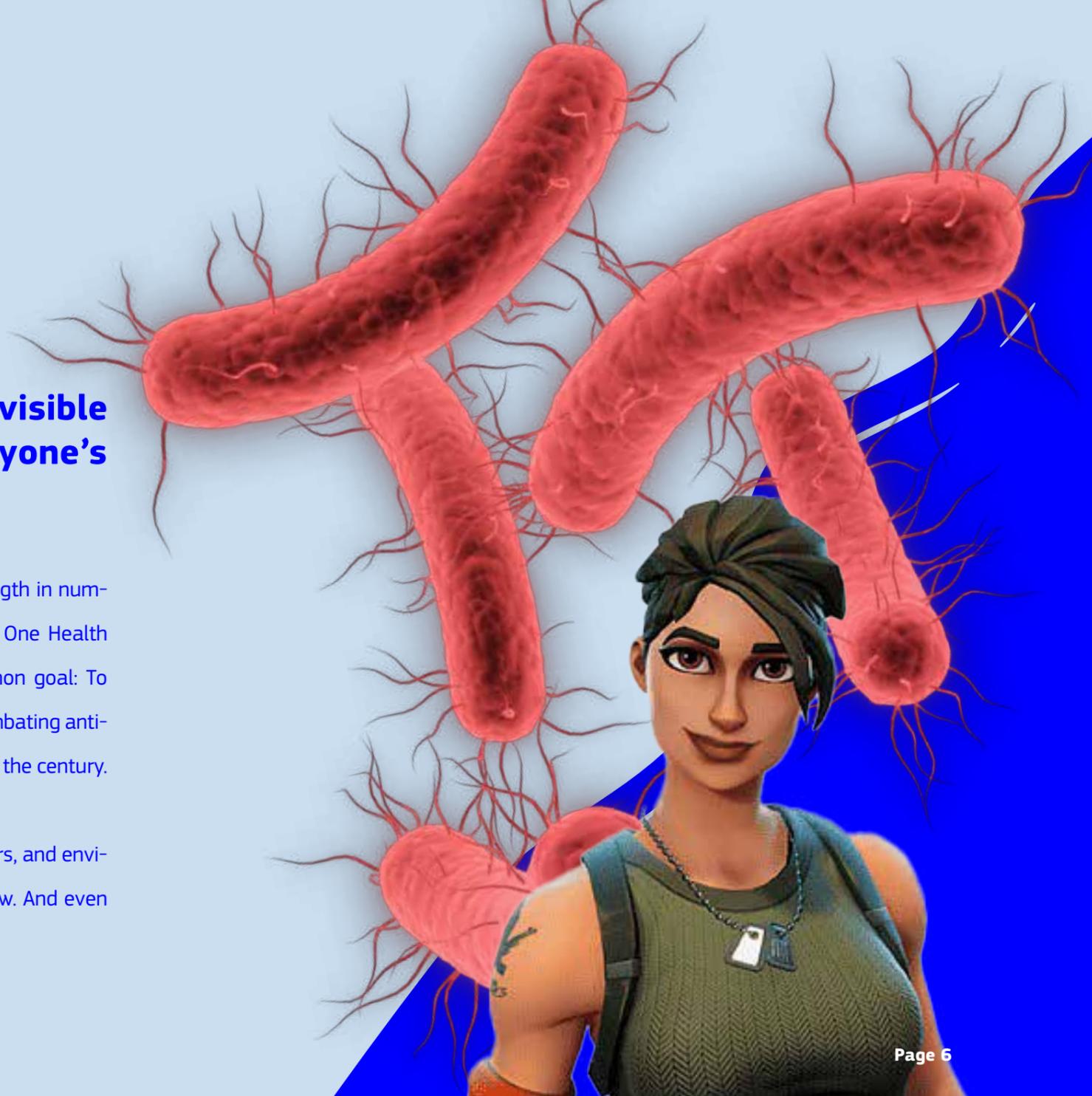
annual cost of antimicrobial resistance in EU and European Economic Area (EEA) countries is nearly €11.7 billion. More than half of this — €6.6 billion — comes from extra health expenditure from treating resistant infections and their consequences. The remaining €5.1 billion is related to economic losses due to reduced participation in the workforce (e.g. premature loss of life or reduced productivity due to long sick leaves).

At the same time, a rise in drug resistance in animals could lead to painful, untreatable illness and cause an 11% drop in livestock production, jeopardizing livelihoods and food security.

That's like having a giant, invisible monster munching on everyone's health and wallets!

The good news is that just as superbugs have strength in numbers, so do we! We can Beat the Bug through the One Health Approach — by working together towards a common goal: To ensure effective antibiotics for all those in need... Combating antibiotic resistance would be the global achievement of the century.

Let's join forces as the doctors, veterinarians, farmers, and environmental scientists of today and those of tomorrow. And even if you are not one of those, you can still play a role!



Here's what we can do:

- 1 LEVEL UP OUR GAME**
Discover what makes us sick, know our Bs from our Vs (bacteria from viruses), learn how infections spread, and which medicine works to fight each of them.
- 2 SPREAD THE WORD**
Talk to our friends and family about antimicrobial resistance and what we can do. Knowledge is power!
- 3 BE SMART ABOUT ANTIBIOTICS**
Only take them when prescribed by a doctor, and never share them with others. Let's not give the superbugs more training!
- 4 GET DOWN WITH THE ONE HEALTH APPROACH**
Understand how everyone needs to get involved in initiatives to combat antimicrobial resistance.

REMEMBER, ANTIMICROBIAL RESISTANCE IS A SERIOUS ISSUE, BUT BY WORKING TOGETHER, WE CAN DEFEAT IT. LET'S WRAP THIS UP...

¹https://ec.europa.eu/commission/presscorner/detail/en/ip_22_6951

² Organisation for Economic Co-operation and Development (OECD). Fighting antimicrobial resistance in the EU/EEA. Embracing a One Health approach. Paris: OECD; 2023. Available at: <https://www.oecd.org/health/health-systems/antimicrobial-resistance.htm>

³ <https://www.weforum.org/agenda/2024/04/why-stemming-the-rise-of-antibiotic-resistance-would-be-the-achievement-of-the-century/>

LESSON 1 OVERVIEW

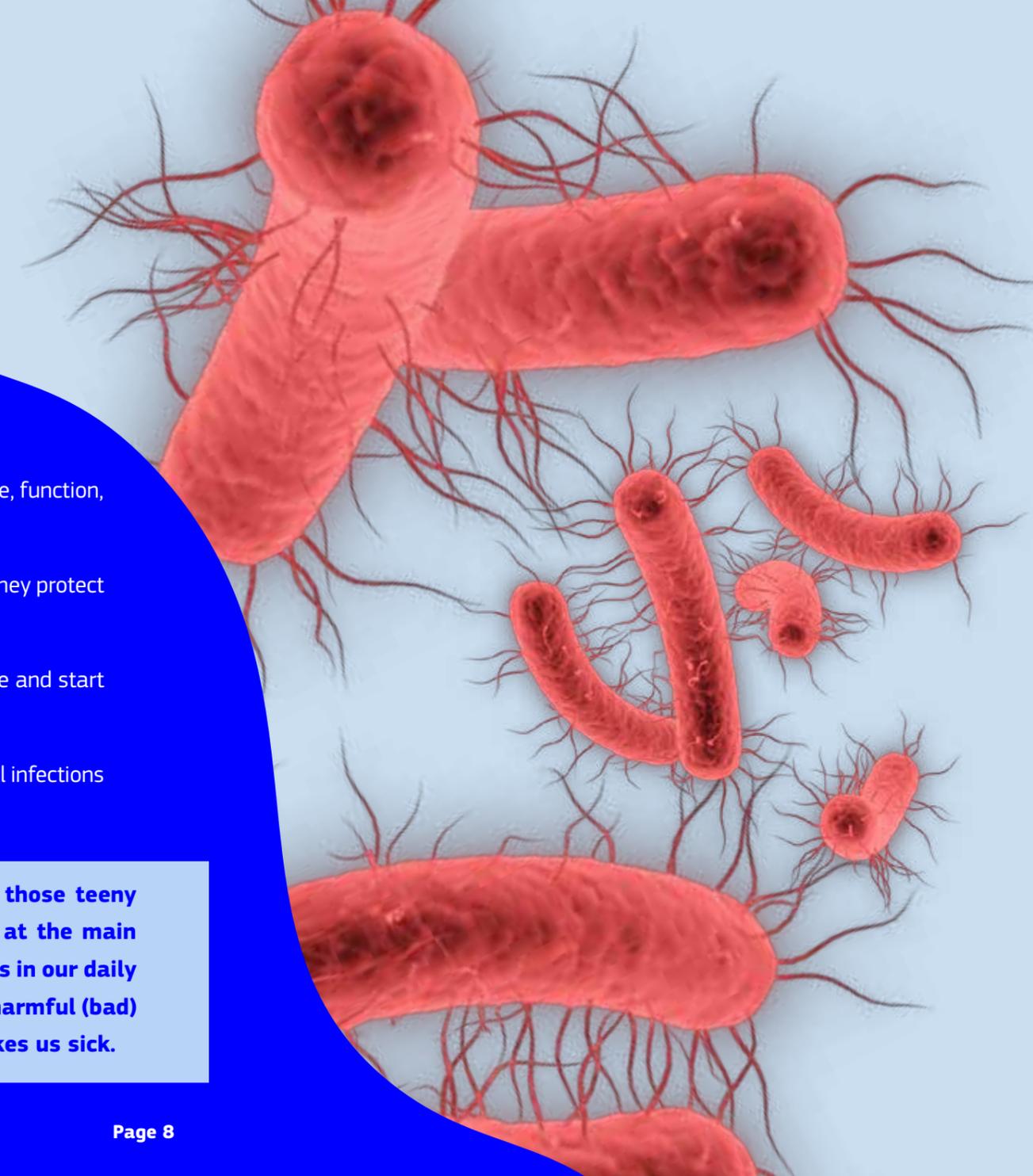
Learning Objectives

By the end of this lesson, students will:

- Understand how their microbiome works: figure out what and where it is and why we need microbes for everything.
- Learn the functions of the human body: check out how and why our major organs depend on and fend off microbes.
- Understand gut health and how to protect it through a balanced diet and nurturing good bacteria.
- Get to grips with the One Health approach in order to practise and share antimicrobial resistance prevention strategies.
- Understand the concept of Prevention is better than cure: The role of infection prevention in the control of antimicrobial resistance.

- Differentiate between bacteria and viruses: their structure, function, and how they interact with our bodies.
- Be introduced to antibiotics and get an overview of how they protect and defend us if used wisely.
- Decode the viral matrix: understand how viruses operate and start to fathom why antibiotics are no match for them.
- Tell the difference: distinguish between bacterial and viral infections based on common symptoms.

This lesson plunges into the world of microbes — those teeny teeming organisms living in and on us. We'll look at the main players: bacteria and viruses and discover their roles in our daily lives. We'll discover how to tell helpful (good) from harmful (bad) bacteria and uncover what keeps us healthy or makes us sick.



GEAR UP FOR EXPLORATION!

We'll be using diverse tools like interactive exercises, clear explanations, and a friendly competition and to solidify their knowledge.

Ready to unpack the secrets of beating superbugs? Let's start by diving into the microscopic world and help students understand how our body systems work.

RESOURCES REQUIRED



Large sheets of paper or poster boards



Scissors and glue



Printed images of organs, microbes (both good and bad), and common pathogens



Post-it notes



Flashcards with organ functions and microbe roles



Timer (optional)



Internet access



Pre-prepared slides or images of gut health (printed or digital).

SUGGESTED PLAN

1. Start the lesson with a presentation on how our bodies work, and how bacteria and viruses affect our health. Cover the following core topics:

- a. What the microbiome is, the four main types of microorganisms, and how they work for or against us.
- b. The ins and outs of bacteria: the difference between “good” and “bad” bacteria, the role of good bacteria in maintaining our health, and a brief introduction to how antibiotics work.
- c. The One Health Approach and why prevention is crucial.
- d. How viruses work and why antibiotics are no match for them.
- e. The difference between bacteria and viruses, the types of illnesses each can give us—and their treatment.

2. Activity 1

3. Activity 2

4. Activity 3

5. Curate a wrap-up discussion and set the stage for Lesson 2: Protect and Prevent.



ACTIVITIES

Here's a sneak peek at the activities planned:

ACTIVITY 1

GUT BUSTERS:

Discover how a balanced diet and knowing good bacteria from bad can help us guard our gut and keep our inner world ship-shape!

ACTIVITY 2

BODY SYSTEMS GO!:

Let's look at our major organs and their superpowers. We'll uncover how microbes keep us healthy and delve into their darker side.

ACTIVITY 3

BACTERIA VS. VIRUSES SHOWDOWN!:

Get to grips with the key differences between bacteria and viruses. Learn how to tell them apart by sussing out symptoms.



READY TO OUTSMART THE SUPERBUGS?

Let's explore the incredible world of microbes and unravel their secrets!

WELCOME THE UNIQUE UNIVERSE OF YOU

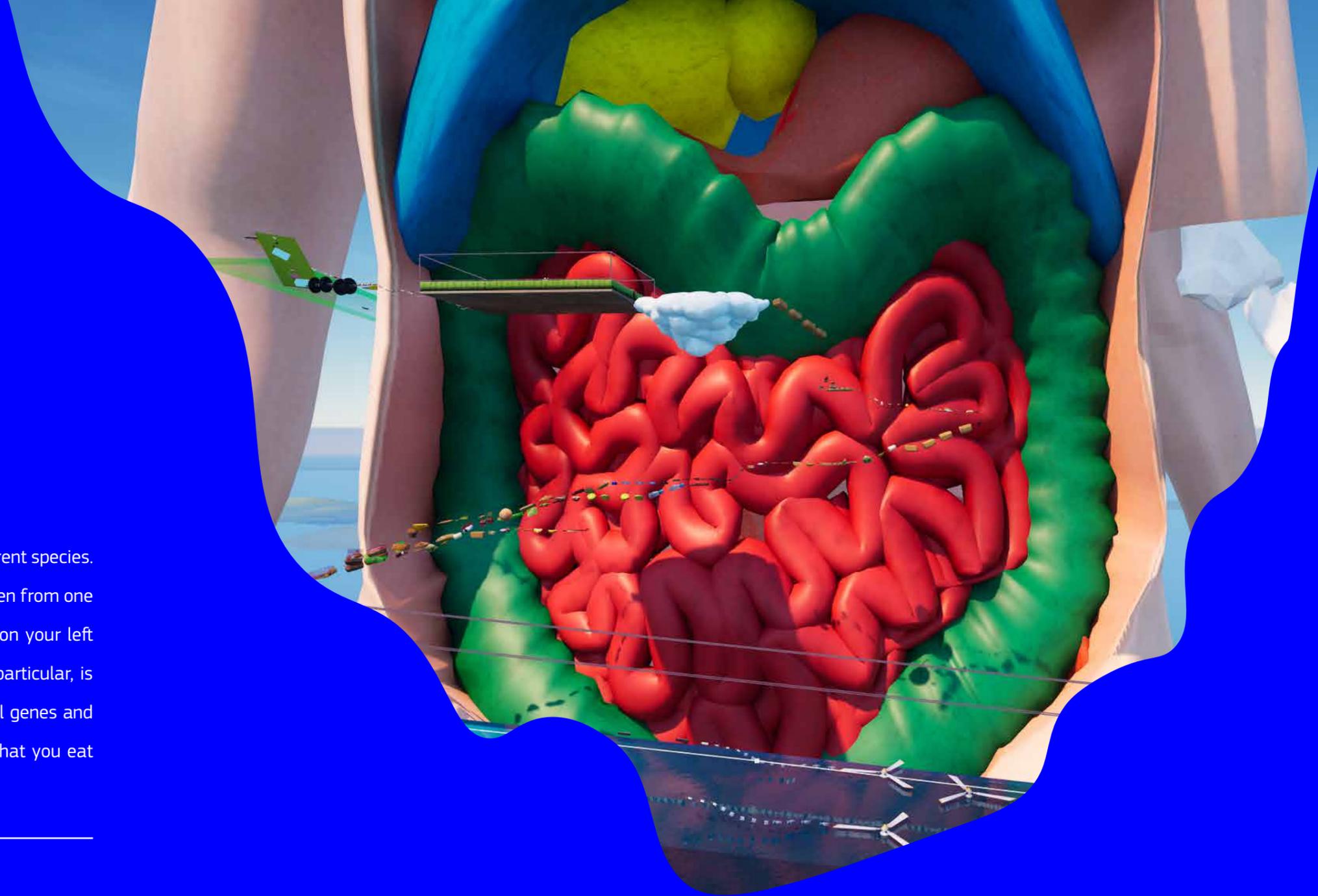
Ever wonder what's living on and inside you? The human microbiome is a hidden universe of tiny organisms, including bacteria, archaea, fungi, v, and viruses. Together, these microbes make up your microbiota, and they're crucial for your health. There are between 75 trillion and 200 trillion bacteria in your body, compared to about 50 trillion to 100 trillion human cells. ⁴ That means you're more microbe than human, making you a «supraorganism»! ⁵

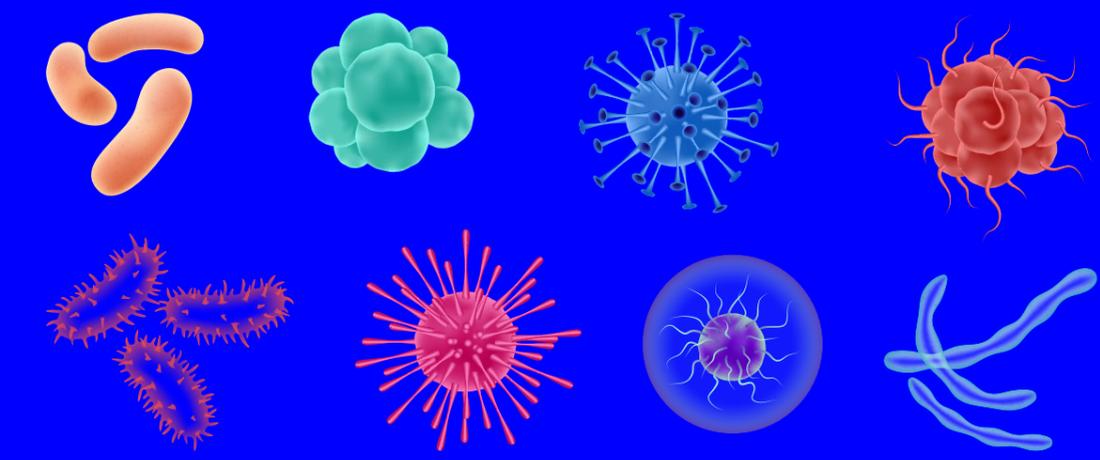
Back in the 1880s, a scientist named Theodor Escherich first spotted bacteria in our guts. Since then, scientists have discovered countless other microorganisms that live on us. The study of the microbiome really took off in the early 2000s, especially after the Human Microbiome Project (HMP) started in 2007. ⁵ This project aimed to map out all these microbial communities and understand how they affect our health, using cutting-edge genome sequencing technology.

Your microbiota is incredibly diverse, with up to 1,000 different species. And they vary a lot—not just from person to person, but even from one part of your body to another. For instance, the microbes on your left hand are different from those on your right. Your gut, in particular, is a hotspot for microbial diversity, with millions of microbial genes and many common bacterial species that change based on what you eat and your genetics.

⁴ <https://www.britannica.com/science/human-microbiome>

⁵ <https://www.hmpdacc.org/>





Most of these microbes are your friends. They help digest food, protect against harmful bacteria, and keep your immune system in check. But some can be troublemakers. Certain strains of bacteria like Staphylococcus, Streptococcus, and Enterococcus are usually harmless residents of your microbiome, but they can cause infections if the conditions are just right.

The ongoing study of the microbiome continues to uncover how vital these tiny organisms are to our overall health and well-being. So, next time you think about what makes you, remember: it's not just your human cells—it's also the incredible world of microbes you carry with you!



WHAT ARE MICROBES?

Microbes —AKA microorganisms— are the oldest forms of life on Earth. They are found everywhere, including on and in people, animals, and the environment.

Microbes are mega consumers. They consume everything. They consume each other, they consume sunlight, they consume nitrogen, they consume sulphur. Inside us, they consume some nutrients our bodies can't break down, like cellulose.

There are **4 main classes of microbe**: bacteria, viruses, fungi, and protozoa.

BUT

Some of these microbes can invade or mutate and can cause disease, throwing our bodies out of balance. The main villains are bacteria and viruses — which are as different as giraffes and goldfish.

FIVE COOL FACTS ABOUT MICROBES⁶

1. *The fastest living thing is a microbe: Bdellovibrio can swim at 60 micrometres per second —600 times its length.*
2. *Microbes could live on Mars (if they could get there). All they need is nitrogen, water, and sulphur.*
3. *We wouldn't be here without them. Every oxygen molecule we inhale is made by a microbe or a descendant of a microbe. The protein in our body got to us through microbes. There would be no plants or cheese or crisps either.*
4. *Microbes can steal your mind (kinda). The gut-brain axis means the microbes in your gut send signals to your brain, impacting how you feel and think.*
5. *Some microbes don't need water. There are microbes in every desert, and in salt flats. They can survive in really dry places.*
6. *When we're born, we don't have any microbes on us at all! But we quickly get them from our mother when she gives birth to us and then through the breastfeeding process. From then on, our bodies are hosts to trillions of them that play an essential role in digestion, protecting us against infection, and keeping all our vital systems working in sync with each other.*

⁶ <https://www.amnh.org/explore/microbe-facts>

BACTERIA CHECKLIST

SINGLE-CELLED? CHECK!

GOT WALLS? CHECK!

REPRODUCE ON THEIR OWN? CHECK!

Bacteria are tiny, resilient micro creatures, each with a tough outer wall and a rubbery membrane protecting their vital insides. They can reproduce on their own and they've been around for 3.5 billion years, surviving everything from scorching heat to freezing cold, and even radioactive waste. They're everywhere on Earth, including inside us—where they outnumber our own cells tenfold! ⁷

American palaeontologist Steven Jay Gould said, "We should forget about the Age of Dinosaurs, forget about the Age of Man—we've always lived in the Age of Bacteria."

Good bacteria are called commensals. They're our body's silent defenders. They hang out on our skin, in our gut, and elsewhere in our body, forming what our microbiome or flora. These helpful bacteria help us absorb nutrients, break down food, and most importantly, keep the bad bacteria in check. This balance is crucial for staying healthy and fighting off infections.

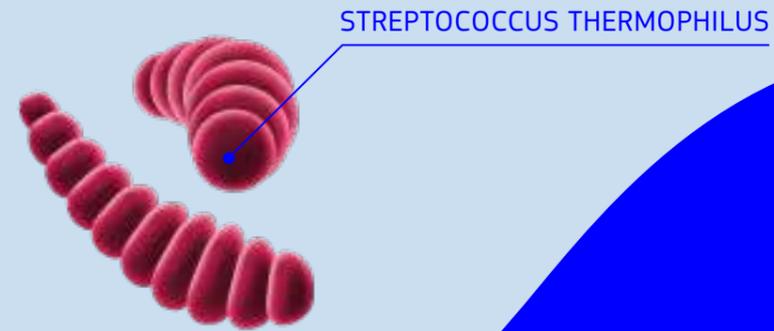
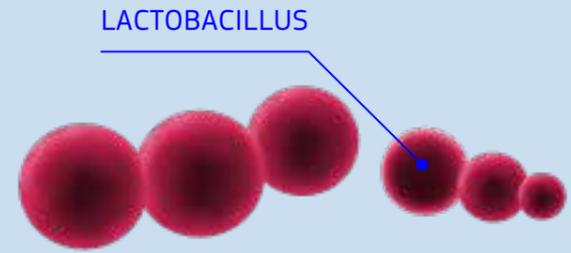
⁷ <https://www.oum.ox.ac.uk/bacterialworld/>

GIVE IT UP FOR YOUR GUT!

Let's take a closer look at gut microbiome and the critical role of beneficial bacteria in our well-being. Imagine trillions of microorganisms coexisting in our digestive system. This microbiome isn't a random collection—it's a bustling community that supports our digestion, metabolism, and overall health.

The gut isn't just a digestion powerhouse—it's a second brain, influencing our mood, emotions, and even decision-making. This «second brain,» known as the enteric nervous system, is made up of millions of neurons lining our gut. It communicates with our main brain through the vagus nerve, sending signals that can affect our feelings of happiness, stress, and even cravings. So, next time you get a «gut feeling,» know that it's not just a figure of speech—your gut might actually be trying to tell you something!

A healthy gut microbiome thrives on diversity, especially with a rich variety of beneficial bacteria. These little helpers work tirelessly to keep us in top shape, making our gut a powerhouse of vitality and resilience. Understanding and nurturing our gut microbiome is essential for living our healthiest lives possible.



THE IMPORTANCE OF GOOD GUT HEALTH

Eating a balanced diet rich in fruits, vegetables, whole grains, and fermented foods can help restore and maintain the balance in your gut. Consuming fibre-rich foods supports the growth of beneficial bacteria, aiding digestion and overall gut health. Staying hydrated and ensuring adequate nutrient intake also contribute to a resilient gut microbiome.

Meet Lactobacillus. These tiny gut guardians are found in yoghurt and other fermented foods. As part of a balanced diet, they can help keep our guts healthy. Lactobacillus is a helpful bacteria that breaks down food,

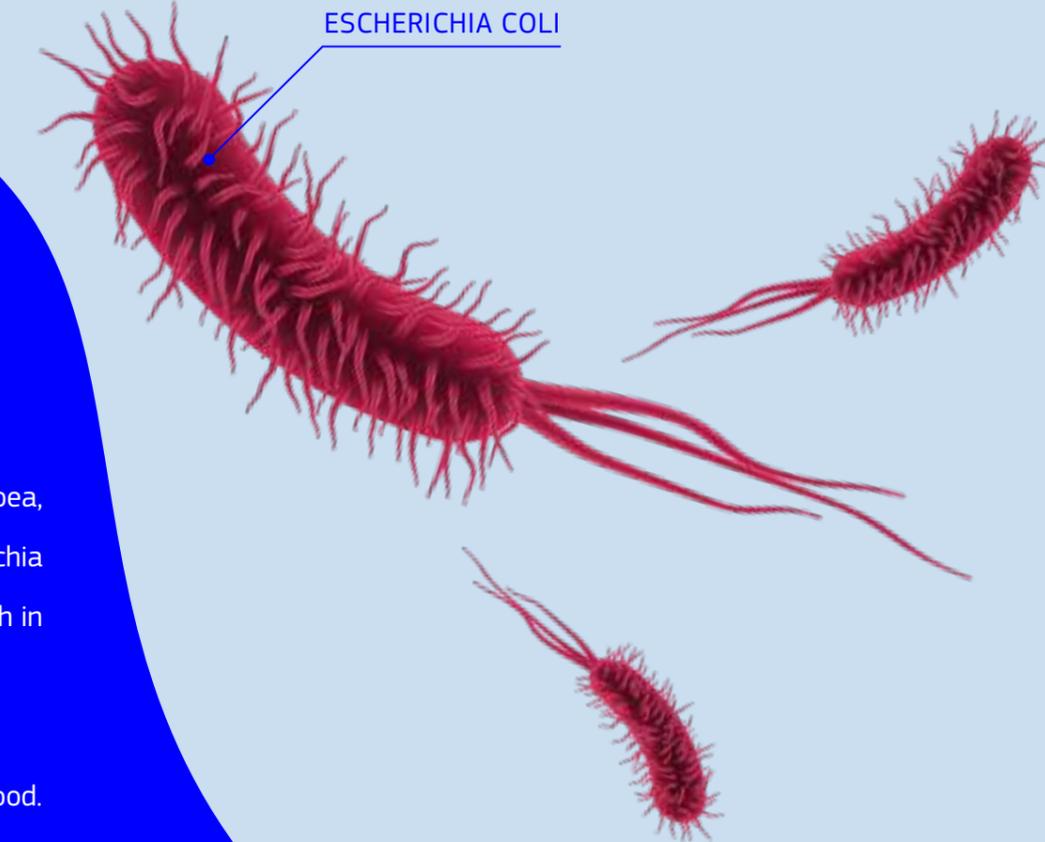
making it easier for our bodies to absorb nutrients. When Lactobacillus digests lactose —the sugar in milk— it produces lactic acid. This gives yoghurt its tangy taste and helps to keep bad bacteria away.

During fermentation, Lactobacillus teams up with another good bacteria, Streptococcus thermophilus, to transform milk into yoghurt. This process thickens the milk and makes it easier to digest, especially for people who are lactose intolerant.

BUT... NOT ALL GUT BACTERIA ARE GOOD

Bad bacteria in the gut can cause problems like tummy aches, diarrhoea, and other infections. For example, a type of bad bacteria called Escherichia coli, or E. coli for short, can make you feel really ill if it grows too much in your intestines.

E. coli can come from eating undercooked meat or contaminated food. While not all types of E. coli are harmful, some can produce toxins that upset your stomach and make you feel sick. It's important to keep the number of bad bacteria low by eating healthy foods and practising good hygiene, like washing your hands before eating. We'll meet this tiny villain again in Lesson 2!



LET'S TALK ABOUT ANTIBIOTICS...

Most of us have taken antibiotics to fight an infection. You probably remember what for. Now let's look at why your doctor prescribed them...

Antibiotics are powerful warriors designed to fight off «bad» bacteria that make us sick. When you get an infection, antibiotics come to the rescue, destroying harmful bacteria and helping you recover— we'll learn all about these wonder-warriors in Lesson 3.

Let's take an example. You have a sore throat caused by bacteria. Your doctor might prescribe an antibiotic . The antibiotic charges into your body, attacking and killing the bacteria causing the infection. Soon, you start feeling better as the bad bacteria are wiped out.

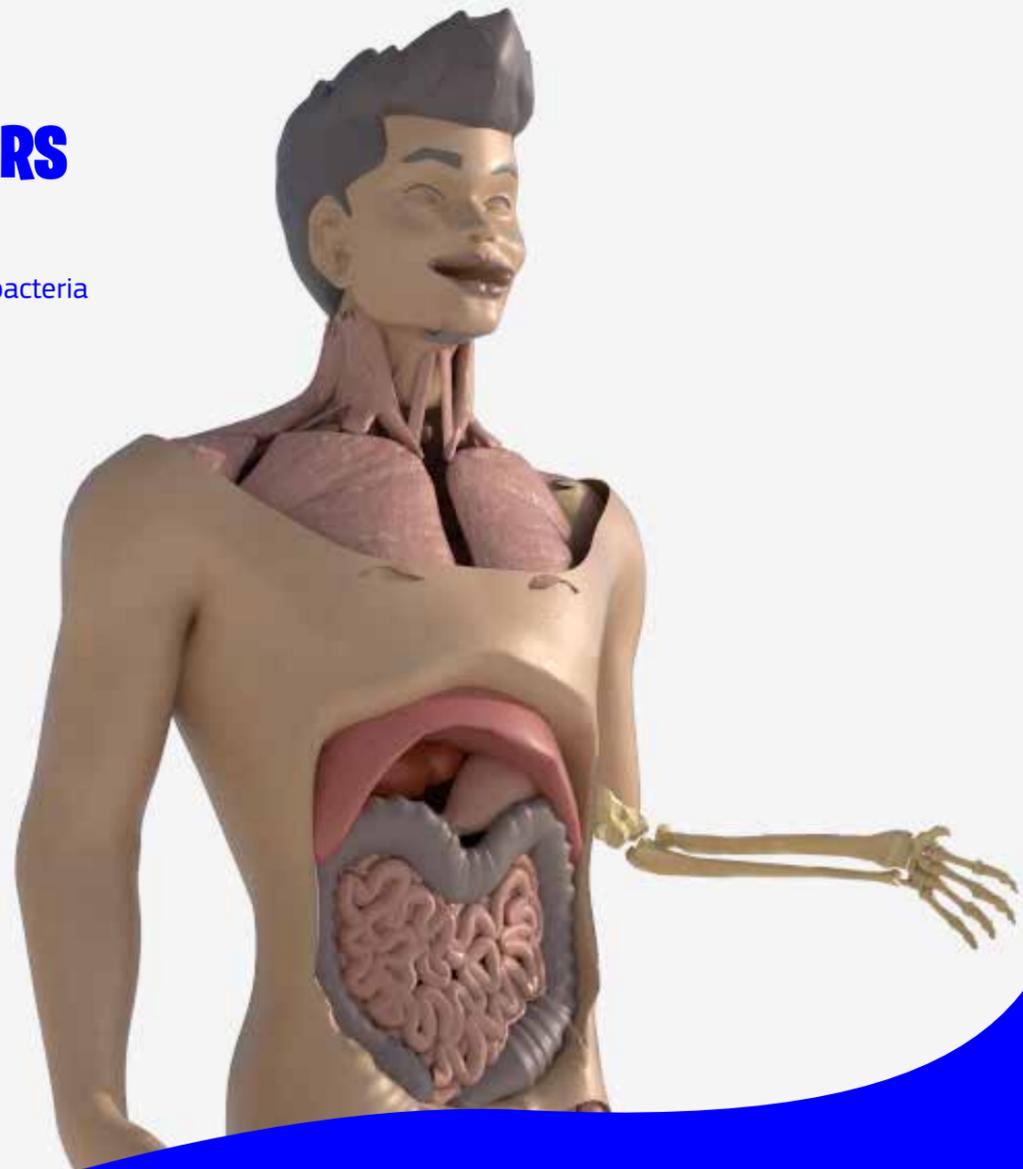
But here's the catch: antibiotics can't tell the difference between good and bad bacteria. They wipe out both, which can sometimes upset the balance in your gut. This is why sometimes after taking antibiotics, you might feel a bit off or have digestive issues.

By prioritising a healthy diet, you support your gut's natural balance and overall well-being, making it easier to bounce back after a course of antibiotics. So, remember to nourish your body with a variety of wholesome foods to keep your gut in top shape!



ACTIVITY 1. GUT BUSTERS

Let's take a closer look at helpful and harmful bacteria and see how they affect our gut health.



ACTIVITY PLAN

Start with an icebreaker to gauge students' knowledge about bacteria and what they've learned so far with a few quick questions:

- o **What are bacteria?**
- o **Are all bacteria harmful?**
- o **Can you name any beneficial bacteria?**

Give a short presentation or show a video about gut microbiome, highlighting the role of beneficial bacteria like *Lactobacillus* and *Bifidobacterium*. Briefly explain how these bacteria help with digestion, nutrient absorption, and immune function. Touch on "bad" bacteria" like *Escherichia coli* (*E. coli*): and *Clostridium difficile* (*C. difficile*) — which can cause serious intestinal conditions such as colitis. Provide infographics or handouts that illustrate the gut microbiome and the benefits of a healthy gut.

Research Activity: Divide students into small groups. Assign each

group a topic related to gut health and bacteria, such as:

- **How can we help good bacteria outnumber bad?**
- **What are some common good bacteria in the gut?**
- **How do bad bacteria affect the gut?**
- **What are some examples of bad bacteria?**
- **How does a balanced diet support good gut health?**

Have each group present their findings to the class.

1. **Class discussion:** Discuss the overall importance of maintaining a healthy gut microbiome. Emphasise the role of a balanced diet in supporting gut health.

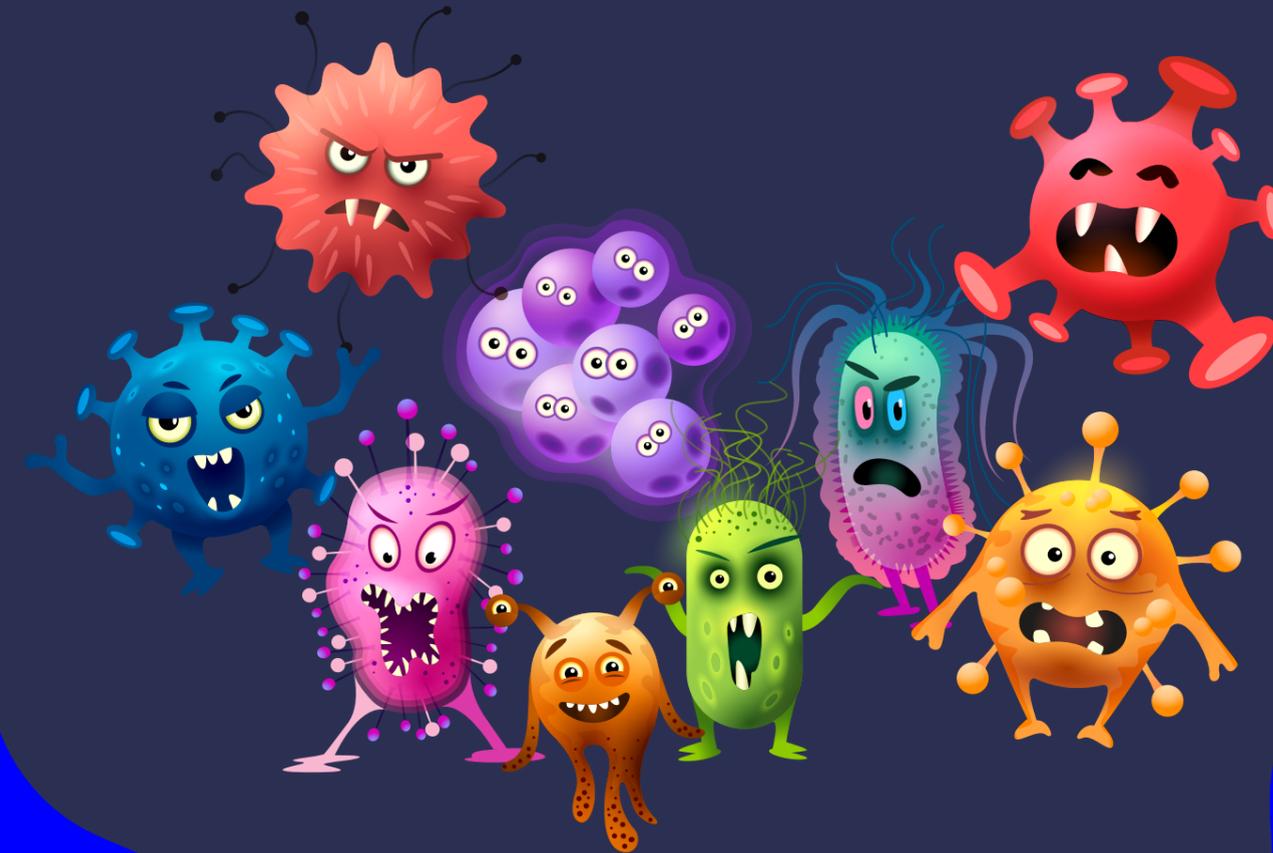
2. **Q&A:** Open the floor for any questions students might have about gut health, beneficial bacteria, or gut-boosting foods.

KNOW YOUR FRIENDS FROM YOUR FOES

Some bacteria are on our side—some are troublemakers. These are known as pathogens and have a knack for causing chaos. They invade or mutate and multiply rapidly inside our body, releasing toxins that can lead to infections and illness, and in severe cases, even threaten lives.

These are some of the diseases, sicknesses that these sneaky pathogens can cause :

- Eye infection
- Strep throat
- Tuberculosis
- Urinary tract infections (UTIs)
- Pneumonia
- Salmonella
- Whooping cough (Pertussis)
- Meningitis



WHO'S WHO—EXTRA POINTS IF YOU CAN PRONOUNCE THEM!

GOODIES

- **Lactobacillus:** Aids digestion and supports gut health
- **Bifidobacterium:** Another beneficial bacterium found in the gut, helps with digestion
- **Propionibacterium acnes:** Helps maintain skin health

BADDIES

- **Streptococcus:** Can cause strep throat and other infections
- **Mycobacterium tuberculosis:** Causes tuberculosis
- **Escherichia coli (E. coli):** Causes urinary tract infections (UTIs)
- **Streptococcus pneumoniae:** Haemophilus influenzae, Mycoplasma pneumoniae:
Can cause bacterial pneumonia
- **Salmonella:** Causes salmonellosis
- **Bordetella pertussis:** Causes whooping cough (Pertussis)
- **Neisseria meningitidis:** Streptococcus pneumoniae, Haemophilus influenzae:
Causes meningitis
- **Staphylococcus aureus:** Commonly found on skin and can cause skin infections
- **Clostridium difficile (C. difficile):** Can cause diarrhoea and inflammation of the colon.

VIRUS CHECKLIST

NON-CELLULAR? CHECK!

GOT NO WALLS? CHECK!

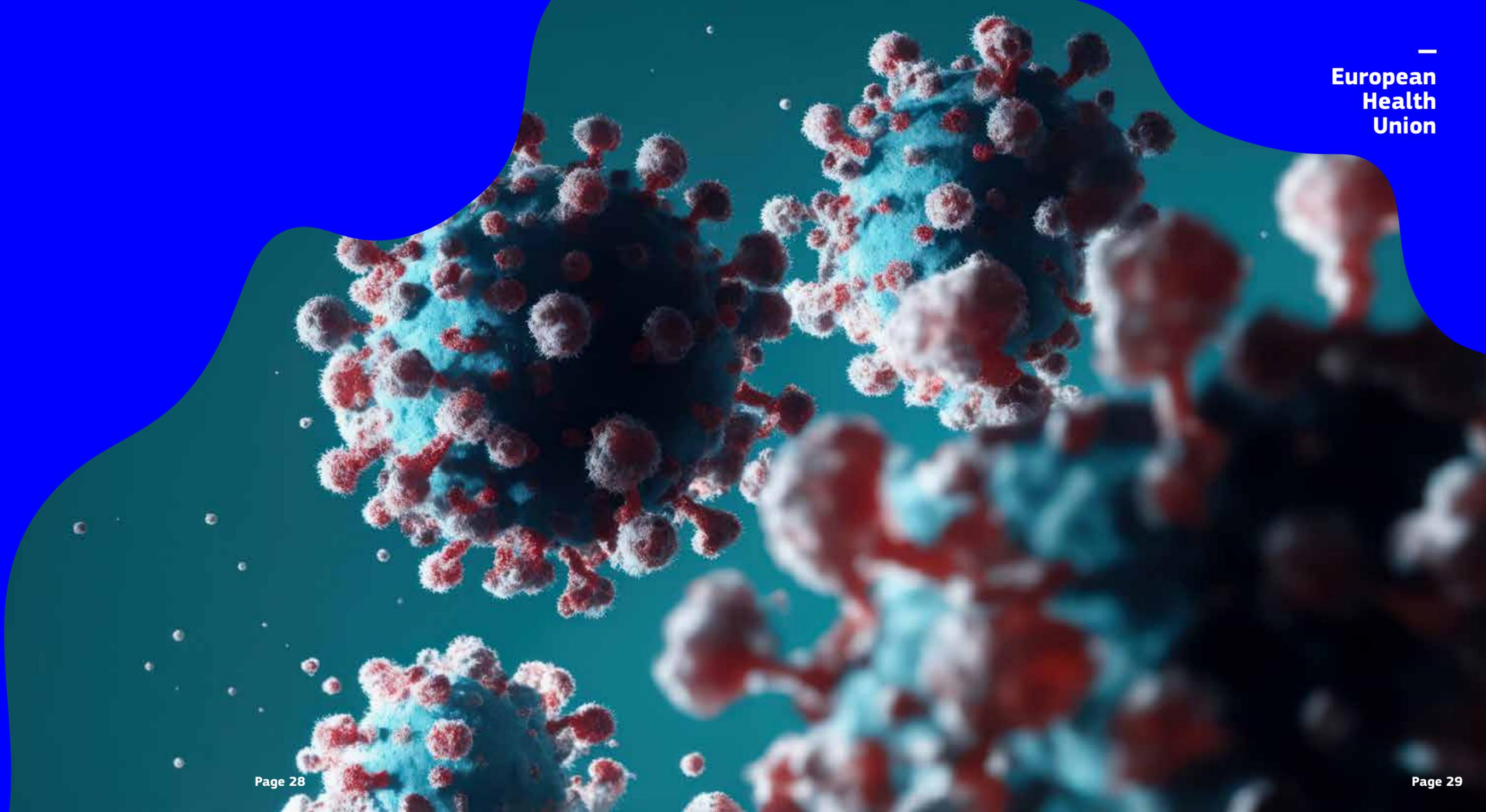
NEED A HOST TO REPRODUCE? CHECK!

- Viruses are tiny, non-cellular organisms that invade living things like humans, plants, or animals. They contain genetic material (either DNA or RNA) coated in a protective protein called a capsid.
- Viruses can't reproduce on their own and instead hijack host cells to make copies of themselves. They can survive outside a host until their protective capsid breaks down.
- Unlike cells in your body, viruses have no cell wall.
- Some viruses also have an additional outer layer called an envelope. Viruses without this envelope are called «naked viruses.»
- They are incredibly small, ranging from 100 to 1,000 times smaller than the cells in your body.⁹

VIRUSES CAN CAUSE DIFFERENT TYPES OF ILLNESSES:

- Influenza (flu)
- AIDS
- Coronavirus (COVID-19)
- Chickenpox
- Measles
- Human papillomaviruses (HPV)
- Common cold
- Smallpox
- Enteroviruses
- Herpes simplex

⁹ <https://erc.europa.eu/projects-statistics/science-stories/how-viruses-invade-cells>



MEET THE VIRAL VILLAINS

- Influenza (flu): Influenza viruses, including types A, B, and C.
- Chickenpox: Varicella-zoster virus (VZV).
- Common cold: Caused by several types of viruses, including rhinoviruses, coronaviruses, and others.
- AIDS: Human Immunodeficiency Virus (HIV).
- Measles: Measles virus (MeV).
- Smallpox: Variola virus
- Coronavirus (COVID-19): Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2).
- Human papillomaviruses (HPV): Various strains of HPV, causing warts and cervical cancer.
- Enteroviruses: Several types of enteroviruses, including polio virus, coxsackievirus, and others, causing various infections.
- Herpes Simplex: Cold sores.

LET'S GET TO KNOW OURSELVES BETTER

Our bodies are amazing. They do so many things at once, every day to keep us healthy and balanced. You probably know how your major organs work, but let's look at what's going on at microbial level.

Think of your body like a superhero squad. Each organ has its own superpower to defend against bacteria and viruses that can make you sick:

Lungs are like turbo-charged air filters, pulling in oxygen and pushing out carbon dioxide. But sometimes, bacteria and viruses can sneak in, causing infections like pneumonia.

The liver is your body's chemical processing plant, breaking down toxins and helping digest fats. It's crucial for detoxifying your blood, but viruses like hepatitis, can cause liver infections and damage.

Your gut —sometimes known as your second brain— is your body's internal

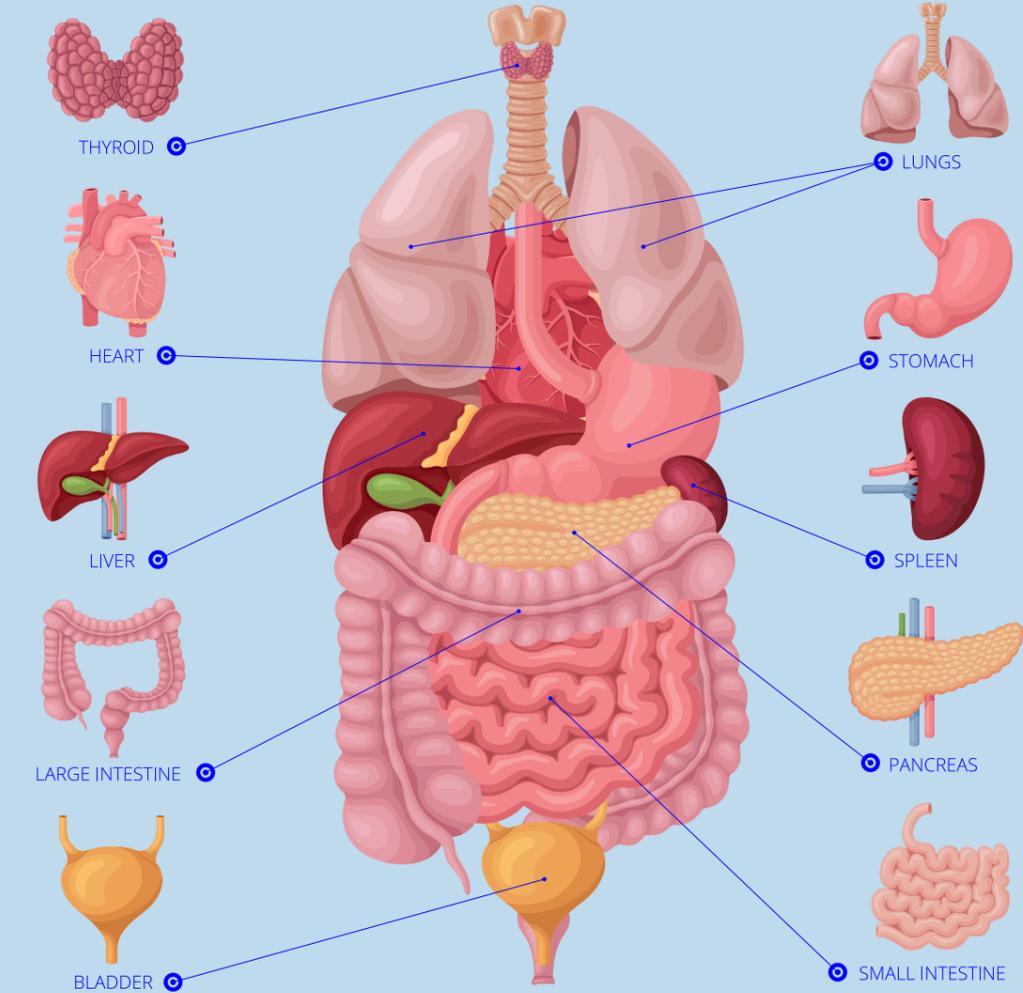
processing and sorting centre. It breaks down food and absorbs nutrients.

The intestines are a city filled with microbes, most of them friendly, but some can turn rogue, leading to stomach bugs and other issues, while others, like salmonella can invade and cause havoc

Your kidneys are super cool—think of them as high-tech water purifiers. They filter out waste and excess fluids from your blood. Sometimes, bacteria can cause kidney infections.

The heart is the powerhouse of your body, pumping blood loaded with oxygen and nutrients to every cell. It works round the clock, but it can get attacked by infections like endocarditis caused by bacteria entering the bloodstream.

The skin, your body's largest organ, is like armour. It keeps out invaders but can get cut or scratched, letting germs in and causing infections like tetanus.



All our organs are amazing in their own way, all of them are interconnected, and they all depend on microbes. Trillions of these teeny tiny organisms live inside you and keep everything that goes on in balance.

Our bodies are home to a mix of good and bad microbes. The good ones usually keep the bad ones in check, but sometimes things go wrong. When harmful bacteria, viruses, or fungi outnumber the good ones or sneak into places they shouldn't be, they can cause infections. For example, if you get a cut, harmful bacteria can enter and cause an infection before the good bacteria can stop them.

Now, here's where the battle against microbes gets intense. Some bacteria are turning into "superbugs" because they resist antibiotics. Antimicrobial resistance (AMR) happens when bacteria change, get new—and sometimes deadly—powers and stop responding to the medicines designed to kill them.

Understanding how your organs work and how infections happen helps you appreciate why it's crucial to use antibiotics properly by following our doctor's advice. The more we misuse them, the stronger these superbugs become. So, let's be smart and help our bodies stay in top shape!





ACTIVITY 2: BODY SYSTEMS GO!

Mission brief: Prepare to journey through the major organs—lungs, heart, liver, kidneys, intestines, and skin. Discover their superpowers: from pumping blood to filtering toxins, each organ has a vital role. Learn about the microbes — those unseen helpers and the sneaky troublemakers, who can either keep us fighting fit or stir up mayhem.

ACTIVITY PLAN: ORGAN MAPPING

- o **Divide students into pairs or small groups**
- o **Give each group a large sheet of paper or poster board.**
- o **Ask them to draw an outline of the human body and label the major organs.**
- o **Provide printed images of organs for them to cut out and paste if drawing is challenging.**

Microbe matching: Hand out flashcards with descriptions of different microbes (good and bad) and their roles (Lactobacillus, Helicobacter pylori, Hepatitis...)

Ask students to match these microbe flashcards with the corresponding organs on their body map. They can write brief descriptions or fun facts about each microbe on sticky notes and place them near the related organ.

Infection scenarios: Present various infection scenarios: pneumonia, tetanus, chicken pox, etc..). Ask students to discuss in their pairs or groups which organs are affected and how the body's good microbes and immune system respond. Encourage them to use the organ map and sticky notes to illustrate the process.

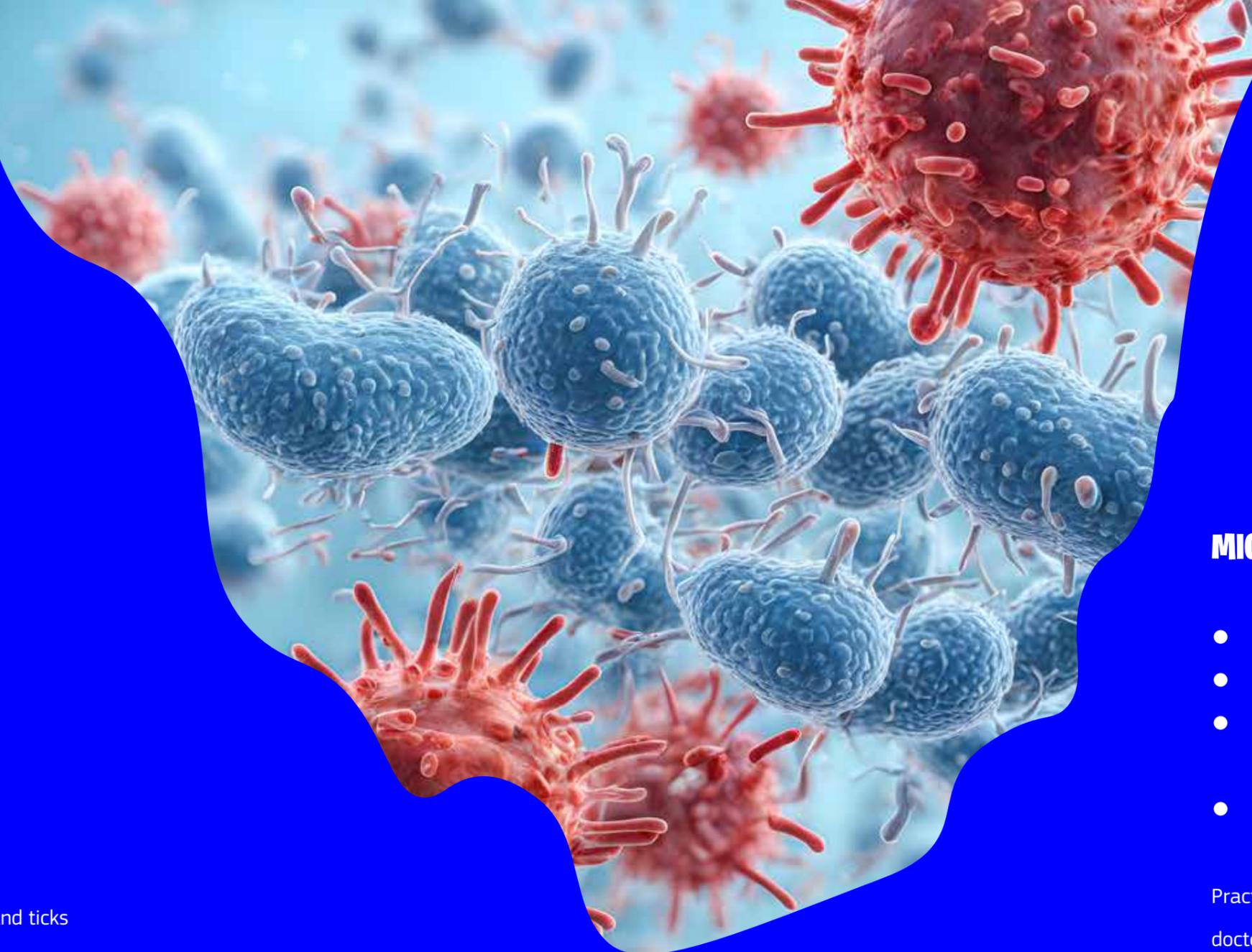
Presentation and discussion: Ask each group to present their body map, microbe matches, and infection scenarios to the class. Facilitate a discussion on what they've learned about their organs and microbes. Summarise key points about how organs function, the role of microbes, and the importance of maintaining balance.

BACTERIA VS. VIRUSES: WHAT'S THE DIFFERENCE?

Bacteria and viruses are different kinds of microorganisms. Both can cause infections that may result in similar symptoms. But bacterial infections and viral infections require different methods of treatment. Healthcare providers may use antibiotics to treat some bacterial infections, **but antibiotics won't work on viruses**. They may treat some viruses with antivirals, **but antivirals won't treat infections caused by bacteria**.

Bacterial and viral infections have loads in common. Both types of infections are caused by microbes and may be spread by things like:

- Coughing and sneezing
- Contact with infected people
- Contact with contaminated surfaces, food, and water
- Contact with infected creatures, including pets, livestock, and insects like fleas and ticks



MICROBES CAN ALSO CAUSE:

- Acute infections, which are short-lived
- Chronic infections, which can last weeks, months, or a lifetime
- Latent infections, which may not cause symptoms at first but can reactivate over a period of months or years.
- Bacterial and viral infections can cause mild, moderate, and severe diseases.

Practising good hygiene and following preventive measures, such as vaccination and following a doctor's advice to the letter are crucial to reducing the spread of both bacterial and viral infections.

More on this in Lesson 2!

A BRIEF HISTORY OF MICROBE MAYHEM

Throughout history, millions of people have died of diseases such as the bubonic plague or the Black Death (caused by *Yersinia pestis* bacteria) and smallpox (caused by the variola virus).

In recent times, viral infections have been responsible for three major pandemics:

- The 1918-1919 Spanish flu pandemic that killed 20-40 million people.⁹
- The ongoing HIV/AIDS pandemic, which has killed over 40.5 million people (as of 2023).¹⁰
- The COVID-19 pandemic, which has killed more than 7 million people worldwide as of May 2024.¹¹

Today, we are facing antimicrobial resistance: if we don't use antibiotics wisely, bacteria become resistant to them, and turn into superbugs.

THAT'S WHY WE NEED TO JOIN...

⁹ <https://www.britannica.com/event/influenza-pandemic-of-1918-1919>

¹⁰ <https://www.who.int/data/gho/data/themes/hiv-aids#:~:text=Global%20situation%20and%20trends%3A,at%20the%20end%20of%202022>

¹¹ <https://data.who.int/dashboards/covid19/cases>



THE WINNING TEAM

In 2017, the EU launched the One Health Action Plan against Antimicrobial Resistance. It's a team effort that connects experts and initiatives to protect human health, animal health, and environmental care. The aim of the One Health Approach is to keep antibiotics working for everyone in the future through:

1. Responsible antibiotic use: We should only use antibiotics for people and animals when absolutely necessary and under the guidance of a doctor or veterinarian. This will help prevent bacteria from becoming resistant.

2. Preventing infections: Better hygiene, vaccinations, and strong biosecurity measures can prevent infections. This means we won't need antibiotics as much, which will help combat antimicrobial resistance.

3. Monitoring and tracking: Scientists are studying how and where antibiotic resistance happens by monitoring its patterns. For example, the Global Antimicrobial Resistance Surveillance System (GLASS) collects information from different countries to see how big the problem is and to help decide what to do next.

4. Research and development: Scientists are investigating and developing new ways to combat resistant bacteria. In Europe, the Innovative Medicines Initiative (IMI) funds projects to discover new treatments and improve how we use current antibiotics. One example is the New Drugs for Bad Bugs (ND4BB) project.

5. Education and awareness: One Health runs campaigns (like this one!) to teach people about antimicrobial resistance and how to use antibiotics correctly. During World Antibiotic Awareness Week, groups like the WHO (World Health Organization) tell everyone about the dangers of AMR and encourage better practices.

6. Antibiotic stewardship programmes: These programmes help doctors, vets, and farmers use antibiotics responsibly. In the EU, the European Surveillance of Veterinary Antimicrobial Consumption (ESVAC) project monitors the use of antibiotics in animals and promotes better practices among vets and farmers.

7. Environmental protection: One Health also looks at how antibiotics get into the environment. It works to control pollution from medicine factories and promotes the proper disposal of medicines to keep them out of our water and soil.

8. Rules and regulations: Governments are encouraged to create and enforce rules about antibiotic use. For instance, the European Union has banned the use of antibiotics to make animals grow faster and has set strict guidelines to reduce antibiotic use in farming.

9. Working together globally: Different countries and organisations are working together. The Tripartite Collaboration on antimicrobial resistance, which includes WHO, FAO (Food and Agriculture Organization), and OIE (World Organisation for Animal Health), coordinates actions across the world to fight antimicrobial resistance.



ACTIVITY 3: BACTERIA VS. VIRUSES SHOWDOWN!

Calling all germ detectives! Can you tell the difference between **bacterial baddies** and **viral villains**? Grab your magnifying glasses and join the fight!

MISSION:

Sort the following infections into two groups: **Team Bacteria** and **Team Virus**. Then, use your detective skills to uncover the secret similarities these tiny foes share!

Infections on the loose:

- Chicken pox
- Influenza (Flu)
- Salmonella
- Common cold
- Meningitis
- Strep throat
- COVID-19
- Most sore throats
- Tuberculosis
- HPV
- Pertussis (whooping cough)
- Urinary tract infections (UTIs)

READY, STEADY, SORT!

Drag and drop each infection into the correct category below.

Remember: This isn't just a sorting game, it's a training exercise! Understanding the difference between bacteria and viruses helps us choose the right weapons (like antibiotics or vaccines) to fight them off and stay healthy. **So, keep those detective skills sharp!**

BACTERIA	SIMILARITIES	VIRUSES
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

Now, for the bonus round! What are some surprising similarities between bacteria and viruses, despite being different types of microscopic troublemakers? Think about things like size, reproduction, and how they make you feel sick. Share your findings with your fellow germ detectives!

OTHER TYPES OF MICROBES

Bacteria and viruses are not the only microbes that can help or hamper our health.

Fungi and protozoa are other types of microbes. Fungi, like moulds and yeasts, can be seen with the naked eye when they grow in big clumps and are awesome at breaking down dead stuff. Protozoa are single-celled critters that usually hang out in water or moist places, zipping around to find their next meal. They can be harmless or cause diseases, and they play major roles in both ecosystems and our health.

Fungi can be good, like the yeast in bread that makes it rise, or bad, like the mould that gives you athlete's foot. Protozoa can be helpful, like those that

help termites munch through wood, or nasty, like Plasmodium, the parasite that causes malaria.

Everything is connected—humans, animals, and microbes. This is why the One Health approach is so vital. Antimicrobial resistance (AMR) happens when microbes, like bacteria and fungi, become resistant to the medicines we use to fight infections. If we don't sort this out, we will rewind to the dark ages, where even minor infections can be deadly!

ROUND UP

Spark a discussion with students to assess their knowledge and what they've learned with a round of questions (Q) and if needed, answer prompts (A).

MICROBIOME 101

Q: What is the microbiome, and where can you find bacteria and viruses in our bodies?

A: It's like a whole city of bacteria and viruses living inside us. They do all sorts of jobs, from helping us digest food to keeping us in a good mood...

BACTERIA VS. VIRUSES

Q: Explain the difference between bacteria and viruses. Give an example of how each can affect our health.

A: Bacteria can be good or bad. Good bacteria help us out, but bad ones can make us sick. Viruses aren't alive like bacteria, but they can cause big problems if they invade our cells....

ANTIBIOTICS

Q Can antibiotics crush a virus?

A: Antibiotics can't crush viruses because they're designed to fight bacteria. If you have a viral infection, antibiotics won't help.

RESISTANCE AND RESPONSIBILITY

Q: Can overusing antibiotics lead to bacteria becoming resistant?

A: Overusing antibiotics can make bacteria resistant as they learn to survive the medicine, making infections harder to treat. This is why it's important to follow a doctor's advice and never share or recycle prescriptions.

ONE HEALTH APPROACH

Q: Why is it important to consider human, animal, and environmental health together when fighting superbugs?

A: Superbugs are bacteria that resist antibiotics, making infections hard to treat. These germs can spread between humans, animals, and the environment. By understanding these connections and working together across different countries and sectors, we can better prevent and control the spread of superbugs. This teamwork helps us identify all sources and pathways of infection, ensuring a more effective fight against these dangerous bacteria.

CRITICAL THINKING

Q: Why is it important for everyone to understand the role of bacteria and viruses in our health?

A: Understanding bacteria and viruses helps us make smart choices about our health, and that of others, like protecting our gut, using antibiotics wisely and washing hands to prevent spreading illnesses in our community.





CLIFFHANGER ALERT!

In this lesson, we got the lowdown on the tiny teeming world of microbes and how they impact our bodies and learned how to identify and differentiate between bacteria and viruses.

In the next lesson, we'll explore prevention and what we can do every day to beat the superbugs. **Stay tuned, this is just the beginning!**

ONLY UP:

BEAT THE BUG

LESSON 1

