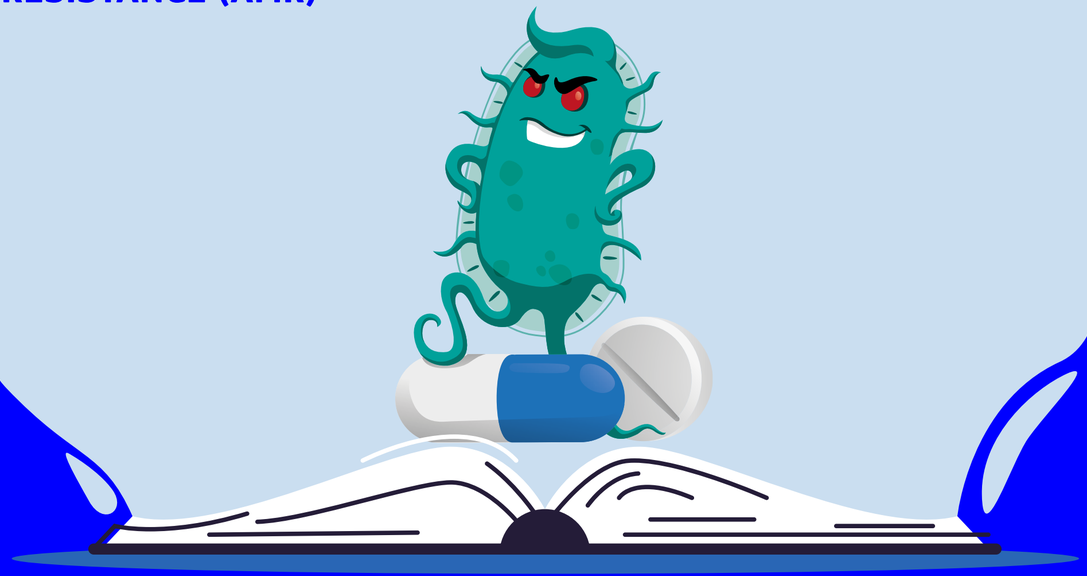

European Commission
ONLY UP:
BEAT THE BUG
LESSON 3

LESSON 3

ANTIBIOTIC USE AND ANTIMICROBIAL RESISTANCE (AMR)



This final lesson in our series delves into antibiotics, which are essential for treating bacterial infections, and explores the rising threat of antimicrobial resistance (AMR). Designed for teenage learners, this lesson connects the science behind antibiotics with practical strategies to prevent antimicrobial resistance, equipping students to be proactive advocates for responsible antibiotic use.

We start with a historical overview of antibiotics, covering their discovery, how they work, and their transformative impact on healthcare. Students will learn about the revolutionary effect antibiotics have had in targeting harmful bacteria and increasing life expectancy, and they will gain insight into the health risks faced before their advent, underscoring the need to preserve these vital medicines.

The lesson explores antimicrobial resistance, explaining how bacteria develop resistance and the global health threats it poses. Interactive discussions and activities highlight how misuse and overuse of antibiotics contribute to the rise of resistant “superbugs.” Students will understand the importance of following prescribed treatments, completing courses, and not sharing antibiotics, recognising their role in combating antimicrobial resistance.

The One Health approach is central to this lesson, which reiterates the interconnectedness of human, animal, and environmental health in managing antimicrobial resistance. Students will devise community strategies based on this approach, thinking critically about their role in preventing resistance. By the end of the lesson, students will have a thorough understanding of antibiotics, antimicrobial resistance, and effective prevention steps. They will be ready to advocate for responsible antibiotic use, promote practices to reduce resistance, and engage in the “Beat the Bug” game to spread key messages about antibiotic stewardship.

LESSON INTRODUCTION

ANTIMICROBIAL RESISTANCE: SUPERHEROES VS SUPERBUGS

!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 superpowers 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.

[1] https://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/

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...

LESSON 3 OVERVIEW
PROTECT AND PREVENT

Recap and ready for action

In Lesson 1, we dived into the microscopic world to discover the microbiome, the vast, diverse community of microorganisms that live in us and on us. We focused on the two main players: bacteria and viruses, pinpointing their differences and understanding their crucial roles in our lives and health.

In Lesson 2, we'll explore practical ways to prevent AMR and to protect our health, communities and the environment to counter the escalation of AMR and reverse some of its worst impacts caused by overuse and misuse of antibiotics.

This lesson is packed with activities that will help students become health defenders, fighting superbugs and stopping the spread of infections through everyday good practices. Discover the power of teamwork as we explore how working together at home, at school, and on the move can help us spread good practices, not microbes!

IT'S TIME TO TURN OUR KNOWLEDGE INTO ACTION.

LESSON 3 OVERVIEW

ANTIBIOTIC USE AND ANTIMICROBIAL RESISTANCE

Learning Objetives

This lesson delves into the world of antibiotics, our most powerful weapons against bacterial infections. We'll explore how they work and why they're crucial. We'll also look at how the growing threat of antimicrobial resistance (AMR) jeopardises their effectiveness, so we know what we're up against and better understand the importance of responsible antibiotic use!

BY THE END OF THIS LESSON, STUDENTS WILL:

- **Understand the history and workings of antibiotics:** learn how these amazing discoveries transformed healthcare and how they work to eliminate harmful bacteria.
- **Surf the pre-antibiotic world:** rewind to a time when even minor infections could be deadly. Learn what it was like before antibiotics saved and lengthened our lives and understand why we can never go back there!
- **Think like an expert:** Explore how the One Health approach can save a city from the rise of resistance with smart thinking.
- **Unravel the mystery of antimicrobial resistance:** discover how bacteria can develop resistance, rendering antibiotics ineffective and posing a serious global health threat.
- **Be part of the solution:** understand the importance of taking antibiotics as prescribed, finishing the entire course, and never sharing them, to reverse the rise of the superbugs.
- **Be ready for action:** have consolidated knowledge and a strong message to take home with them, as well as enthusiasm and curiosity to play Beat the Bug.
- **Understand the One Health approach:** We all have a role to play in working together to prevent diseases spreading, manage antibiotic use, and protect human, animal, and environmental health.

GET READY TO EXPLORE!

We'll use engaging activities, informative presentations, and interactive discussions to solidify your understanding. Remember, your participation is crucial. So, get ready to ask questions, share your thoughts, and become champions of responsible antibiotic use!

RESOURCES REQUIRED

- Printed scenario cards
- Whiteboard or large paper
- Markers
- Worksheets for recording strategies and results
- Printed quiz sheets
- Worksheets for recording strategies and results

SUGGESTED PLAN

1. Start the lesson with a presentation on the background of antibiotics and antibiotic resistance that covers the following topics:

a) What antibiotics are, how they work and their mechanism of action.

b) How antibiotics were accidentally discovered by Alexander Fleming.

c) What the world was like before antibiotics and a deep dive into the development of antibiotics, highlighting peaks, like during World War 1, when people with injuries died from bacterial infections.

d) Antibiotic resistance and how and why it happens.

e) The impact of antibiotic resistance on our health and global health.

f) How everyone can help prevent antibiotic resistance from intensifying by:

- only using antibiotics when prescribed by a doctor
- finishing your course of antibiotics as recommended by your doctor
- not using leftover antibiotics and giving any leftovers to your local pharmacy to dispose of.
- not resorting to antibiotics for most earaches, sore throats, or any colds or flu — which are usually caused by viruses.

2. **Activity 1**
3. **Activity 2**
4. **Activity 3**
5. **Conclusion:** Wrap up with a roundup of this lesson and the previous two, summarising the core aspects of antimicrobial resistance, responsible antibiotic use, good hygiene and the One Health Approach. Encourage students to carry the main messages to their homes and communities and play Beat the Bug.

ACTIVITIES

Here's a sneak peek at the activities planned:

ACTIVITY 1

FRIENDS, OR FOES?

Work out what antibiotics can and can't do in everyday situations and how to use them correctly.

ACTIVITY 2

TEST YOUR ANTIBIOTIC

IQ with multiple-choice questions about how antibiotics fight infections, are crucial in recovery from serious illnesses and the importance of keeping them effective to save lives.

ACTIVITY 3

CALLING ALL HEALTH WARRIORS!

You're working to tackle antimicrobial resistance in the face of two of the most resistant bacteria. Your teams must develop a game plan to prevent the spread of resistance.

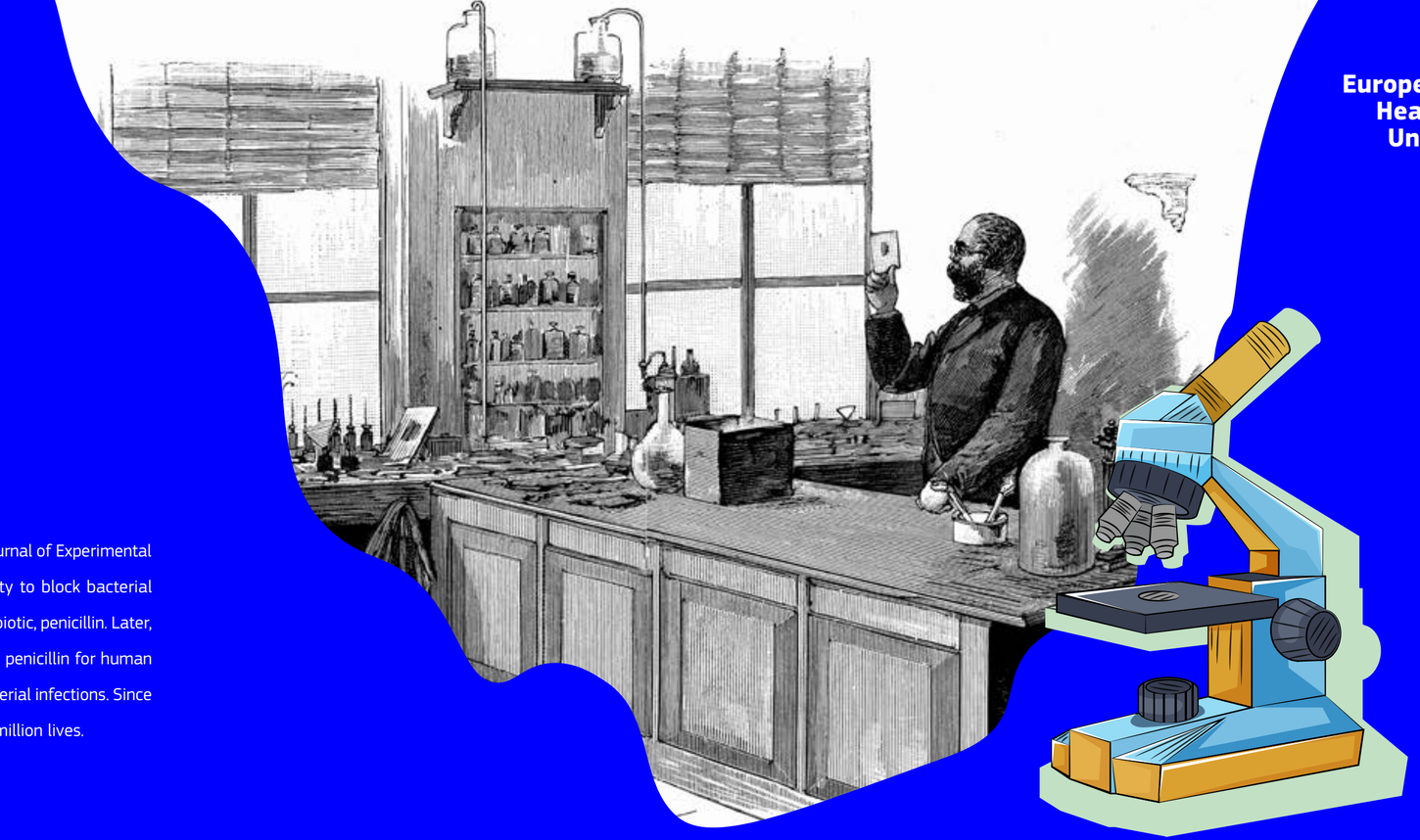
READY TO JOIN THE FIGHT AGAINST SUPERBUGS? LET'S DIVE BACK INTO THE MICROSCOPIC WORLD AND BECOME RESPONSIBLE ANTIBIOTIC HEROES!

EDUCATIONAL MATERIAL

ANTIBIOTICS: THE BACK STORY

In 1928, Alexander Fleming, a bacteriologist working at St. Mary's Hospital in London, came back from holiday to find something strange in one of his petri dishes. The dish, which contained staphylococci bacteria, was contaminated with mould. To Fleming's surprise, the mould, identified as Penicillium notatum, was preventing the bacteria from growing. He discovered that this mould produced a powerful antibacterial substance, which he named penicillin.

Fleming documented his findings in The British Journal of Experimental Pathology in 1929, highlighting penicillin's ability to block bacterial growth. This marked the discovery of the first antibiotic, penicillin. Later, scientists Ernst Chain and Howard Florey purified penicillin for human use in 1942, revolutionising the treatment of bacterial infections. Since then, penicillin has saved an estimated 80–200 million lives.



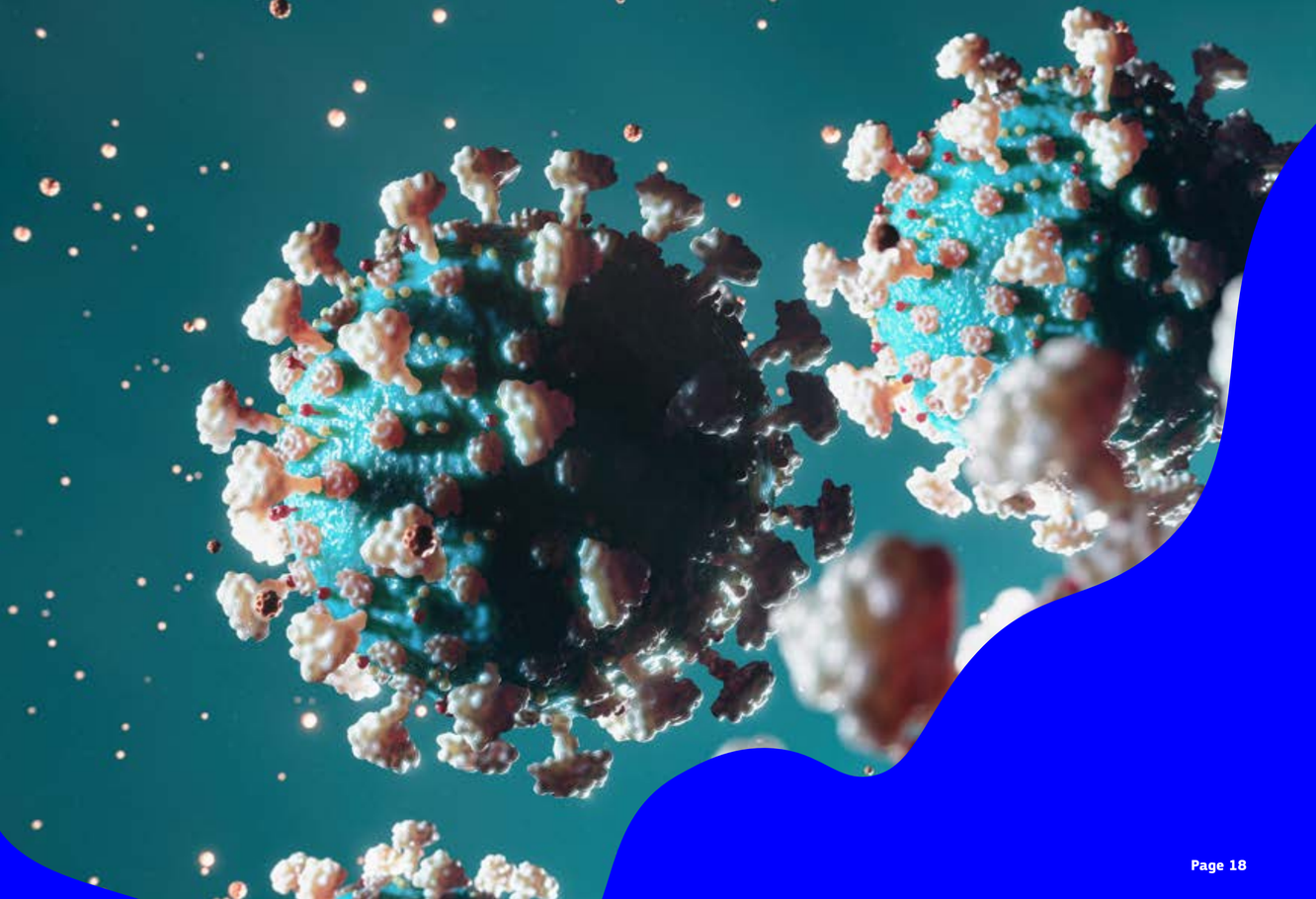
THE WORLD BEFORE ANTIBIOTICS

Before antibiotics, bacterial infections were often life-threatening. In the early 20th century, infectious diseases were the leading cause of death worldwide, and the average life expectancy in Europe was just 47 years at birth. Diseases like smallpox, cholera, diphtheria, pneumonia, typhoid fever, plague, tuberculosis, typhus, and syphilis were extremely difficult to treat. During World War I and World War II, millions of people died from infected injuries because antibiotics weren't available. Today, life expectancy is 81.5 years at birth!

ANTIMICROBIAL RESISTANCE: WHAT'S THE WORST-CASE SCENARIO?

Imagine a world where antibiotics no longer work. If we don't tackle antimicrobial resistance (AMR), even minor infections could become deadly again. Routine surgeries, cancer treatments, and organ transplants would carry extreme risks due to untreatable infections. Superbugs could make previously curable diseases dangerous once more, leading to higher mortality rates and prolonged illnesses.

But all is not lost. Together, we can fight back against superbugs! Remember what we learned in Lessons 1 and 2:



TEN HACKS TO SEND SUPERBUGS PACKING!

1) Hand hygiene: Wash your hands as the first thing you do when you go inside after being outside, especially before touching food or after touching animals or after coughing or sneezing into your hands.

2) Cover up: No tissue? Cough/sneeze into your elbow.

3) Prescription power: Only use antibiotics when and how your doc says so. No self-prescribing or sharing!

4) Bust the right baddies: Remember that some bacterial infections clear up without meds.

5) Cold hard truth: Remember that antibiotics don't work on viruses like colds, flu, RSV, or COVID-19.

6) Fight not flight: Always finish your antibiotic course, even if you feel better. Don't leave any bacteria behind to regroup.

7) Leave the leftovers: Don't use leftover antibiotics. Return any extras to your local pharmacy for safe disposal.

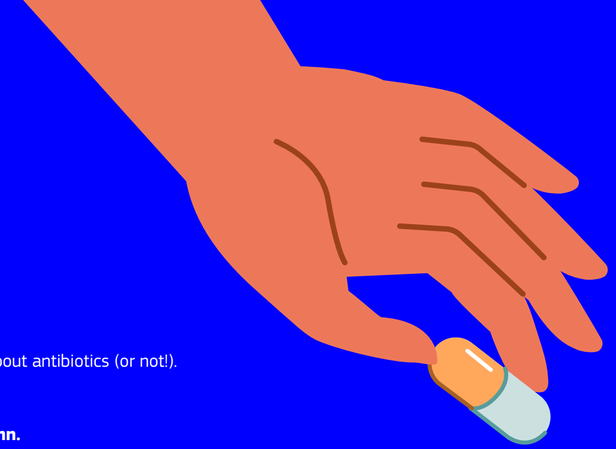
8) Stay up to date on shots: Keep your vaccinations up to date to prevent infections that might need antibiotics.

9) Wear a mask if needed — especially in crowded places and around old or vulnerable people.

10) Don't feed the bugs: Always wash veggies and keep cooked and raw food apart.

We can keep these powerful medicines effective for future generations. It's time to get onboard with the One Health approach, to understand and tell everyone we know about how human, animal, and environmental health are all connected. Together, we can promote practices that protect antibiotics and prevent the spread of resistance across all fronts. So, let's get smart. get equipped and join the mission to save our antibiotics and protect everyone's health!

ACTIVITY 1.
ANTIBIOTICS: FRIEND ZOR FOE?
SORT IT OUT!



INSTRUCTIONS:

Below are several statements about antibiotics (or not!).

Put them in the correct column.

1) Kill bacteria
2) Treat the symptoms (runny nose, sore throat)
3) Help you get better from a cold more quickly
4) Stop bacteria from growing
5) Kill viruses
6) Help staphylococcal infections get better more quickly
7) Kill all the good and bad bacteria in the body
8) Help all coughs get better more quickly
9) Help all sore throats get better more quickly
10) Help all earache get better more quickly
11) Help asthma get better more quickly
12) Help your body flush out a UTI.

ACTIVITY 1 ANSWERS

ANTIBIOTICS CAN:

- **Kill bacteria:** This is their main function. They can eliminate harmful bacteria causing infections like UTIs, skin infections, ear infections, and some sore throats. (Statements 1, 6, 10, 12)

- **Stop bacteria from growing:** While they don't treat symptoms directly, by eliminating the infection, they help your body recover faster. (Statements 4 and 6)

ANTIBIOTICS CANNOT:

- **Treat only symptoms:** They address the root cause, the bacteria, not just the symptoms like fever or fatigue. (Statement 2)

- **Help colds and all coughs get better:** These are mostly caused by viruses, not bacteria, and antibiotics won't work against them. (Statements 3, 7, 8, 11)

- **Kill viruses:** Antibiotics are specifically designed to target bacteria, not viruses. (Statement 5)

- **Help all earache get better:** (Statement 10)

- **Kill all «good» bacteria:** While they do target some good bacteria in the gut, this effect is usually temporary and shouldn't be a major concern with proper use. (Statement 7)

- **Help all sore throats get better:** Some sore throats are bacterial and can benefit from antibiotics, but others are viral and won't respond to them. (Statement 9)

DISCUSSION FOR ACTIVITY 1

- Classify the statements about antibiotics correctly. Recap how antibiotics are used to treat bacterial infections by targeting and killing harmful bacteria. Discuss why antibiotics are effective against bacterial infections but not viral illnesses

- Discuss the importance of consulting your doctor for any illness so that he or she can diagnose the cause and prescribe the appropriate treatment, including antibiotics when needed. Remember that doctors may not always need to prescribe antibiotics. Explain that It's a good idea to ask your doctor to do a rapid test first, to see if you have a virus or bacteria. That way, you will only take antibiotics if you have a bacterial infection.

- Reiterate the importance of taking antibiotics with a prescription, using them for what they are prescribed for and completing the course to curb the rise of antibiotic resistance.

- Open the floor for questions and answers.

MEET THE CHAMPIONS OF MODERN MEDICINE

Antibiotics are powerful, lifesaving medications designed to target bacteria and treat or prevent bacterial infections. They're like special agents, hunting down harmful bacteria and eliminating or weakening them so our bodies can fight back, and we can feel better.

1. HOW DO ANTIBIOTICS BEAT BACTERIA?

Antibiotics fight bacterial infections in two main ways:

1. Killing bacteria: Some antibiotics destroy crucial parts of bacteria, like their cell walls or DNA. This is like knocking down the walls of a fortress — without their protective walls, bacteria can't survive.

2. Stopping bacteria growth: Other antibiotics prevent bacteria from making certain proteins they need to multiply. Imagine stopping an enemy from gathering more troops — without these proteins, bacteria can't grow or spread.

2. AMAZING THINGS ANTIBIOTICS HAVE DONE

Antibiotics have done some mind-blowing things since they were first discovered. Here are a few examples of how they've made a huge difference to the way we live today.

1. Curing deadly diseases: Before antibiotics, diseases like tuberculosis (TB) and pneumonia were often fatal. Antibiotics have turned these once-deadly infections into treatable illnesses. Thanks to antibiotics, millions of lives have been saved.

2. Saving lives in surgery: Antibiotics are crucial during some surgeries to prevent infections. They've made it possible for doctors to perform complex surgeries like transplants safely. After a transplant, a patient's immune system is often suppressed to prevent organ rejection, making them more susceptible to infections. Antibiotics help protect these patients, allowing the transplanted organ to function properly and the patient to recover safely.

3. Cancer treatment: Antibiotics play a vital role in cancer treatment. They help prevent and treat infections in patients whose immune systems are weakened by chemotherapy. Without an[illegible] would make many cancer treatments much r[illegible]

4. Treating common infections: Everyday infections like str[illegible] or urinary tract infections (UTIs) used to be serious or even deadly. [illegible]biotics make it easy to treat these common ailments, allowing people to recover quickly and get back to their normal lives. And it's not just humans that benefit. **We use them on our animals too!**

5. Helping us to live longer: Antibiotics have significantly increased human life expectancy. Before their discovery, bacterial infections were a leading cause of death.

Antibiotics have been a game-changer in medicine, enabling the doctors who prescribe them treat a wide range of bacterial infections effectively. By understanding how they work and using them wisely, we can keep on benefiting from their lifesaving power while stopping the spread of the superbugs.

ANTIBIOTIC USES

Doctors and veterinarians use their professional knowledge to prescribe antibiotics for a bacterial infection if the outcome of the patient will be worse by leaving it untreated.
Some infections need antibiotics to get better, like bacterial meningitis and UTIs. Some infections can cause serious problems and lead to worse health issues, like kidney infections or pneumonia.

Sometimes, doctors give antibiotics to prevent infections before they even start. This is called antibiotic prophylaxis:

1. Before surgery: If you're having an advanced operation, antibiotics can help prevent infections.

2. After a bite or wound: If you get a bite or a deep cut, antibiotics can stop it from getting infected.

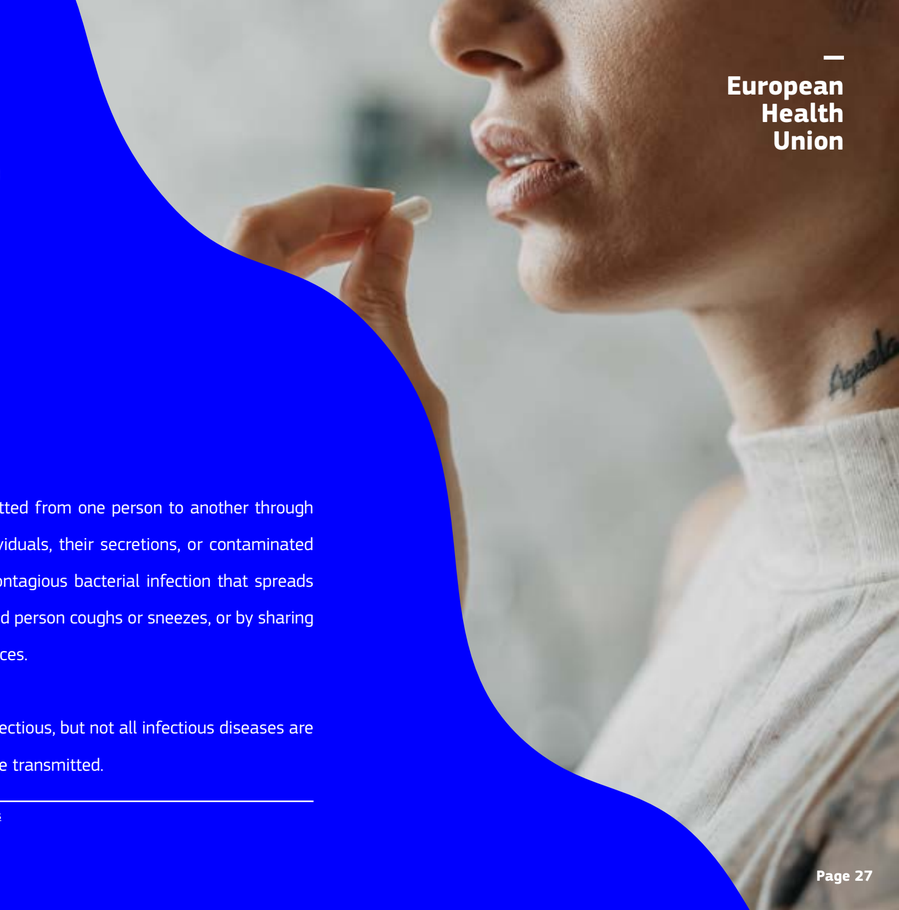
3. If you're at higher risk: People with certain health problems, like those without a spleen or those undergoing chemotherapy, might need antibiotics to stay safe from infections.

SPECIAL SITUATIONS

High-risk surgery: For operations that are more likely to cause infections, doctors may recommend antibiotics to keep you healthy.

***Wondering what the difference is between "infectious" and "contagious"? in a nutshell:**

An infectious disease is caused by pathogens (baddies) such as bacteria, viruses, fungi, or parasites that enter, survive, and multiply in the host. For example: Tuberculosis (TB) is an infectious disease caused by the bacterium Mycobacterium tuberculosis. Infectious diseases can spread through various means, including air, water, food, vectors (like insects that bite us) [4] , and direct contact.



A contagious disease can be easily transmitted from one person to another through direct or indirect contact with infected individuals, their secretions, or contaminated objects. [5] For example: Strep throat is a contagious bacterial infection that spreads through respiratory droplets when an infected person coughs or sneezes, or by sharing food, drinks, or touching contaminated surfaces.

Golden rule: all contagious diseases are infectious, but not all infectious diseases are contagious. The difference is in HOW they are transmitted.

[4] https://www.efsa.europa.eu/en/topics/topic/vector-borne-diseases
[5] https://www.ecdc.europa.eu/en

ANTIBIOTIC CATEGORIES

Doctors and veterinarians prescribe three main types of antibiotics:

1. Narrow-spectrum antibiotics are typically the first choice for treating infections because they target specific types of bacteria, which helps reduce the risk of developing antibiotic resistance. Penicillin are examples of narrow-spectrum antibiotics. Is often used as the first-line treatment for many common bacterial infections.

2. Broad-spectrum antibiotics are used when narrow-spectrum antibiotics are not effective or suitable. These antibiotics are effective against a wide range of bacteria. Examples include Cephalosporins, Tetracyclines, Macrolides, and Fluoroquinolones.

3. Last-resort antibiotics are reserved for severe, life-threatening infections that do not respond to other treatments, especially when dealing with multi-drug-resistant bacteria. These antibiotics are used cautiously to prevent the development of further resistance. Carbapenems and Colistin are examples of last-resort antibiotics, often used in critical situations where other antibiotics didn't work.

COMMON TYPES OF ANTIBIOTICS AND HOW THEY WORK

1. Penicillin — AKA Amoxicillin, Penicillin

How they work: Penicillin stops bacteria from building their protective cell wall. Without a strong wall, bacteria burst and die.

2. Cephalosporins — AKA Cephalexin, Ceftriaxone

How they work: Like penicillin, cephalosporins weaken bacteria by messing up their cell wall. This makes it hard for bacteria to survive and multiply.

3. Aminoglycosides — AKA Gentamicin, Amikacin

How they work: Aminoglycosides block bacteria from making essential proteins. Without these proteins, bacteria can't survive.

4. Tetracyclines — AKA Doxycycline, Tetracycline

How they work: Tetracyclines stop bacteria from making proteins they need to grow and spread. This helps to stop the infection from getting worse.

5. Macrolides— AKA Azithromycin, Erythromycin

How they work: Macrolides interfere with bacteria's ability to make proteins, which are crucial for their survival. This stops the bacteria from growing and spreading.

6. Fluoroquinolones — AKA Ciprofloxacin, Levofloxacin

How they work: Fluoroquinolones mess up bacterial DNA, stopping them from reproducing. This helps to kill the bacteria causing the infection.

7. Carbapenems — AKA Meropenem, Imipenem

How they work: Carbapenems inhibit the synthesis of bacterial cell walls, like penicillin and cephalosporins, but are highly effective against a broad range of bacteria, including many that are resistant to other antibiotics.

Colistin — AKA Polymyxin E

How it works: Colistin disrupts the outer membrane of gram-negative bacteria, making it one of the last-resort antibiotics used to treat multidrug-resistant infections.

HOW ANTIBIOTICS FIGHT INFECTIONS - LET'S BREAK IT DOWN!

- Eroding cell walls: Penicillin and cephalosporins break down bacteria's protective wall, causing them to burst and die.
- Blocking protein production: Aminoglycosides tetracyclines and macrolides interfere with bacteria's ability to make proteins, which they need to survive and multiply.
- Disrupting DNA: Fluoroquinolones target bacteria's DNA, preventing them from replicating and spreading the infection.

Understanding how antibiotics work helps doctors choose the best treatment for bacterial infections. Always use antibiotics as directed by your doctor to ensure they work effectively and to prevent bacteria from becoming resistant!

Antibiotics may cause side effects that can make you feel less than heroic. This is because they sometimes disrupt the balance of good bacteria in your gut, which can lead to:

- Being sick
- Feeling sick
- Bloating and indigestion
- Diarrhea

But don't worry, these side effects are normal and usually go away once you finish your course of antibiotics. To help your tummy feel better, you can try taking probiotics, which are good bacteria that help restore balance in your gut. If you're feeling unwell, ask your doctor for advice.

ACTIVITY 2:
TEST YOUR ANTIBIOTIC IQ!

Instructions for teachers

Knowing how antibiotics work is half the battle won! Divide students into small groups and let their critical thinking shine. Put their knowledge about antibiotics and their impact on health to the test. This quiz has been designed to challenge – and improve – their understanding of how antibiotics work and their role in life-saving medicine.

Question 1: Why are antibiotics important during surgeries, especially complex ones like transplants?

A) They help the transplanted organ to grow faster.

B) They prevent infections, especially when the patient's immune system is suppressed.

C) They boost the patient's energy levels post-surgery.

D) They speed up the healing of surgical wounds.

Question 2: How have antibiotics changed the treatment of common infections like strep throat or urinary tract infections (UTIs)?

A) They have turned these once-deadly infections into easily trea table illnesses.

B) They have made these infections more common.

C) They have increased the duration of these illnesses.

D) They have no effect on the treatment of these infections.

Question 3: How do antibiotics contribute to cancer treatment?

A) They directly kill cancer cells.

B) They reduce pain

C) They prevent and treat infections in patients with weakened immune systems.

D) They help in reducing the size of tumours.

Question 4: Why might a doctor prescribe antibiotics before surgery?

A) To speed up the recovery process

B) To reduce the pain during surgery

C) To prevent infections from occurring during or after the surgery

D) To help the patient sleep better

Question 5: Which type of infection might need antibiotics to clear up faster if it lingers too long?

A. Bad bacterial infection

B. Viral cold

C. Seasonal allergies

D. Skin rash from poison ivy

Question 6: In which special situation might someone need antibiotics to prevent infections even if they are not currently sick?

A) After eating a meal with raw and cooked food on the same plate

B) Before playing sports

C) Before travelling to a different country

D) After a bite or wound

Question 7: What is the main difference between an infectious disease and a contagious disease?

A) Infectious diseases are caused by bacteria, while contagious diseases are caused by viruses.

B) Infectious diseases can be spread by vectors, but contagious diseases are only spread through direct contact.

C) All infectious diseases are contagious, but not all contagious diseases are infectious.

D) Infectious diseases can be transmitted through various means, whereas contagious diseases are specifically transmitted through direct or indirect contact with infected individuals or contaminated objects.

Question 8: How do antibiotics fight bacterial infections?

A) By destroying the bacteria's cell walls or DNA.

B) By stopping bacteria from making necessary proteins.

C) Either A and B.

D) By strengthening the bacteria's defences.

Question 9: Match the antibiotic type with its purpose

1. Narrow spectrum	**A) Reserved for severe, life-threatening infections resistant to other treatments.**
2. Broad spectrum	**B) Firsthand choice in most cases. Targets specific bacteria to minimise resistance risk.**
3. Last resort	**C) Used against a wide range of bacteria when narrow spectrum antibiotics are inappropriate, for example when sensitivity tests show that the bacteria is not sensitive to narrow spectrum antibiotics, or the patient is allergic to the first hand choice.**

ANSWERS.

Question 1: B) They prevent infections, especially when the patient's immune system is suppressed.

Question 2: A) They have turned these once-deadly infections into easily treatable illnesses.

Question 3: C) They prevent and treat infections in patients with weakened immune systems.

Question 4: C) To prevent infections from occurring during or after the surgery.

Question 5: A) Bad bacterial infection.

Question 6: D) After a bite or wound.

Question 7: D) Infectious diseases can be transmitted through various means, whereas contagious diseases are specifically transmitted through direct or indirect contact with infected individuals or contaminated objects.

Question 8: C) Both A and B.

Question 9:

Narrow spectrum: B) Targets specific bacteria to minimise resistance risk.

Broad spectrum: C) Used against a wide range of bacteria when narrow spectrum antibiotics are inappropriate.

Last resort: A) Reserved for severe, life-threatening infections resistant to other treatments.

DISCUSSION FOR ACTIVITY 2: TEST YOUR ANTIBIOTIC IQ!

1. Quiz review: Go over the answers to the quiz, focusing on the importance of antibiotics, and the difference between infectious and contagious diseases. Discuss any surprising answers and share insights gained about the role of antibiotics in various medical scenarios.

2. Myth busting: Address common misconceptions about antibiotics and emphasise the importance of understanding when antibiotics should and shouldn't be used to prevent misuse and overuse.

3. Safe not sorry: Emphasise the importance of never guessing, never assuming, never sharing prescriptions, never giving or taking recycled antibiotics, never taking them for something they were not intended for, or prescribed for, and never trusting Dr Internet: Always take advice and medicine from a professional prescriber.

4. Community engagement: Brainstorm ideas for raising awareness about antibiotic resistance in the community. Discuss the role of education and advocacy in promoting responsible antibiotic use among peers and family members. Encourage students to come up with strategies to spread accurate information and promote good practices in their own circles.

HOW ANTIMICROBIAL RESISTANCE HAPPENS: THE SPREAD OF SUPERBUGS

Imagine bacteria with superpowers. Through increased exposure to antibiotics, bacteria are becoming resistant to them. This means the medicines we rely on to zap these nasty critters are starting to lose their punch. Misusing and overusing antibiotics are the main reasons why these superbugs are getting stronger. The bacteria defeat the medicine designed to kill them. Resistant infections can be difficult, and sometimes impossible, to treat. This means that bacterial infections are once again becoming life-threatening. Humans can have allergic reactions to antibiotics, but we cannot not become resistant to antibiotics — superbugs on the other hand...well that's another story.

ANTIBIOTIC RESISTANCE (AR) METHODS

Bacteria have some sneaky tricks to dodge antibiotics. Here are the four main ways they do it:

Shielding: Some bacteria block antibiotics from entering their cell.

Disguise: They can modify or camouflage critical target sites, making it hard for antibiotics to recognise them.

Destroy: Bacteria produce chemicals to target and inactivate the antibiotic.

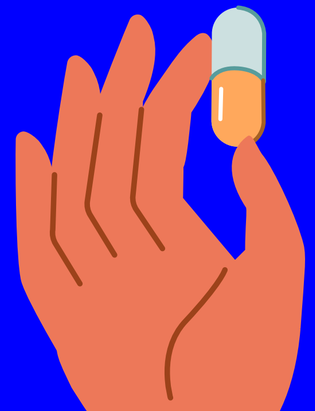
Eject: They pump the antibiotic out of the cell, a process called active drug efflux.

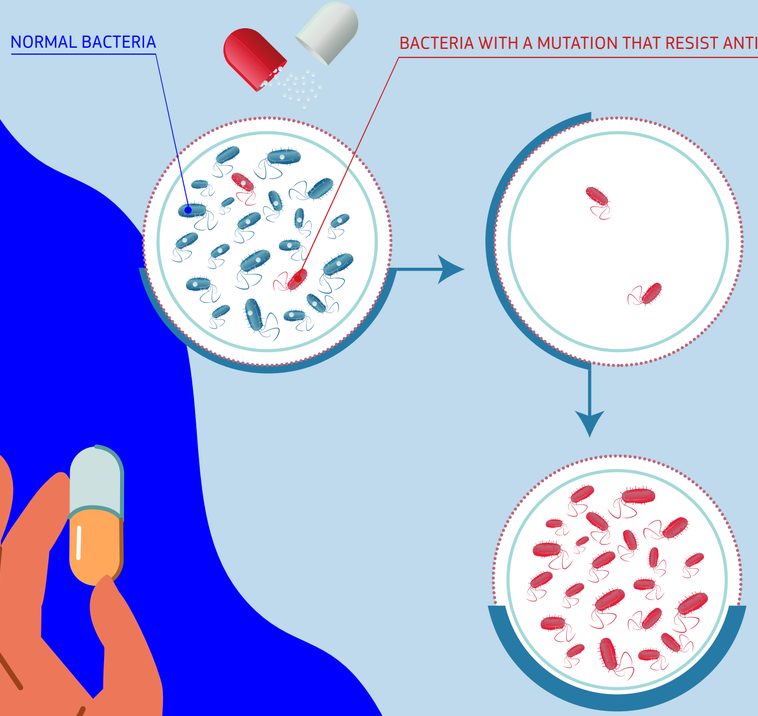
WHAT IS ACTIVE DRUG EFFLUX?

Active drug efflux is like a doorman who throws out anyone causing trouble. Bacteria use special proteins called efflux pumps to eject antibiotics from their cells. These pumps recognise the antibiotic molecules and actively ferry them out, making the bacteria resistant to the drug. It's a clever way for bacteria to survive and keep multiplying, even when we've taken antibiotics

THE RISE OF RESISTANCE

Bacteria can share their resistance genes with each other and with different types of bacteria through a process called horizontal gene transfer. This involves the transfer of genetic material between bacteria, often via plasmids (small DNA molecules) in a process like passing secret codes. Once resistance develops, it can spread very quickly, like gossip in the school canteen!





WHY IS THIS A BIG DEAL...

Antimicrobial resistance (AMR) is a major health threat in Europe. It poses one of the greatest risks to human health and is one of the top 3 health threats identified by the European Commission's Health Emergency Preparedness and Response Authority (HERA) that require coordination measures at EU level. It causes over 35,000 deaths and €1.5 billion in costs each year.[6]

A continued rise in resistance would result in an estimated 10 million deaths globally each year by 2050.[7]

According to a Eurobarometer survey, 1 in 2 people don't know that antibiotics don't work against viruses.[8]

UNDERSTANDING ANTIBIOTIC RESISTANCE: ESBL AND MRSA

Antibiotic resistance occurs when bacteria evolve and adapt, making antibiotics—the medicine designed to kill them—less effective. Two particularly dangerous types of antibiotic-resistant bacteria are ESBL (Extended-Spectrum Beta-Lactamase) producing bacteria and MRSA (Methicillin-Resistant Staphylococcus aureus).

ESBL-producing bacteria, like certain forms of E. coli, can break down many antibiotics that would normally kill them. MRSA is known for causing tough to-treat skin infections because it resists multiple antibiotics.

6 https://ec.europa.eu/commission/presscorner/detail/en/ip_22_6951
7 https://www.who.int/news/item/29-04-2019-new-report-calls-for-urgent-action-to-avert-antimicrobial-resistance-crisis
8 https://europa.eu/eurobarometer/surveys/detail/2632

WHAT IS ESBL?

ESBL-producing bacteria include certain strains of E. coli and Klebsiella pneumoniae, that produce an enzyme called beta-lactamase. This enzyme breaks down beta-lactam antibiotics, such as Penicillins and Cephalosporins, making them ineffective. These bacteria are often found in the gut but can cause serious infections, especially in the urinary tract, bloodstream, and lungs. The ability of ESBL-producing bacteria to resist multiple antibiotics makes infections difficult to treat, leading to longer hospital stays, higher medical costs, and an increased risk of complications.

WHAT IS MRSA?

MRSA stands for Methicillin-Resistant Staphylococcus aureus. Staphylococcus aureus, or "staph," is a common bacterium found on the skin and in the noses of healthy people. While it usually doesn't cause harm, it can sometimes lead to infections, particularly in cuts or open wounds. MRSA is a strain of staph that has developed resistance to methicillin and other common antibiotics like penicillin and amoxicillin. This makes MRSA infections difficult to treat and potentially life-threatening if they spread to the bloodstream, lungs, or other parts of the body. MRSA is notorious for causing hard-to-treat skin infections, often appearing as red, swollen, and painful areas on the skin, sometimes filled with pus.

HOW DO THESE BACTERIA SPREAD?

Both ESBL-producing bacteria and MRSA can spread from person to person through direct contact with infected wounds, contaminated surfaces, or by sharing personal items like towels or razors. They can also spread in healthcare settings, where people with weakened immune systems are more vulnerable to infections. ESBLs can also be transmitted through contaminated food, particularly meat that has not been cooked properly. The spread of these bacteria between humans and animals is also a concern, especially in settings like farms, where antibiotics are sometimes overused in livestock.

The overuse and misuse of antibiotics in humans and animals are key factors contributing to the spread of resistance. For example, using antibiotics when they are not needed, such as for viral infections like the common cold, gives bacteria more opportunities to develop resistance.

WHAT CAN WE DO?

Understanding how resistant bacteria like ESBL and MRSA spread, and the importance of responsible antibiotic use can help curb the spread of these dangerous pathogens. Here is a quick recap on the steps we can take:

- Only take antibiotics when prescribed by a healthcare professional, and always complete the full course of treatment, even if you start feeling better.
- Practice good hygiene like regular handwashing, keeping wounds clean, and avoiding sharing personal items to help prevent the spread of resistant bacteria.
- Staying up to date with recommended vaccines can prevent infections that might otherwise require antibiotic treatment.
- Cooking meat and rinsing vegetables thoroughly and practicing good food hygiene can avoid infections from contaminated food.
- In agricultural settings, using antibiotics in animals only when necessary and under veterinary guidance is important to prevent the spread of resistance between animals and humans.

WAIT A MINUTE... WHY CAN'T SCIENTISTS JUST INVENT MORE ANTIBIOTICS?

Creating new antibiotics isn't as easy as inventing a new video game. Researchers spend years and millions of euros developing just one. Plus, bacteria evolve quickly, sometimes faster than we can create new meds. This is why we must use the antibiotics we have wisely and only when necessary. If we don't, we might run out of options to fight infections in the future. So, let's be smart and help preserve these lifesaving champions.

ACTIVITY 3: COMBATING RESISTANCE – THE ONE HEALTH APPROACH

INSTRUCTIONS FOR TEACHERS:

- **Set the scene:** Explain to students that they will act as scientists, farmers, doctors, vets and teachers working together to combat an outbreak of MRSA and ESBL in their city or town. They'll use real-world ideas and data to create their strategies.
- **Form teams:** Divide students into two groups and give each group a scenario card. Each card will describe a different challenge related to antibiotic use and resistance for either MRSA or ESBL. Students should choose their role (profession).
- **Develop strategies:** Have each group read their scenario card, research the bacteria in question and brainstorm solutions. Encourage them to consider:
  - Responsible use of antibiotics
  - Good hygiene practices
  - Vaccination programmes
  - Public education
  - Monitoring and tracking resistance

Students should create a strategy plan and write down their ideas.

DISCUSSION FOR ACTIVITY 3: COMBATING RESISTANCE

- Present and discuss: Both groups will present their scenarios and strategies to the class, explaining why their approach is effective and how it addresses the challenges of MRSA or ESBL. and the different aspects of antimicrobial resistance.
- Reflect on and evaluate:
  - Which strategies were most effective and why?
  - How can these strategies be applied in real life?
  - What other actions could help tackle antibiotic resistance?
  - The importance of a collaborative approach.
  - **Real-world applications:** Connect the strategies from the activity to real-world practices. Discuss how similar approaches are used globally to manage and prevent antibiotic resistance. Revisit the key points from Lesson 1 on how the One Health approach helps support these efforts.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BEAT THE BUG
LESSON 3