

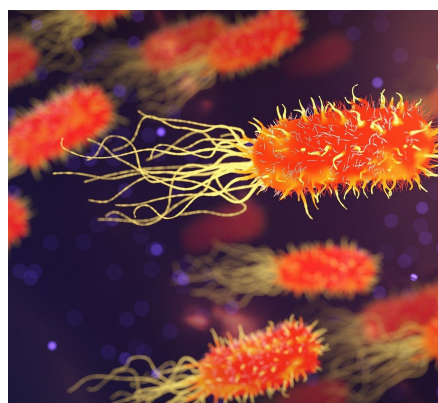


SAFE

SUPERBUG AWARENESS FOR EDUCATION

EDUCATIONAL GUIDE ON ANTIMICROBIAL RESISTANCE FOR STUDENTS

Learning-Service methods in the field of Antimicrobial Resistance to promote awareness and research for new antibiotic-producing microorganisms



KNOWLEDGE

Tools to introduce the concepts of Antimicrobial Resistance, lab sessions, scientific communication and promotion of healthy habits

SAFE, THE PROJECT

Introduction to the SAFE project and the dynamics and activities we offer (service-learning, Youth Congresses, virtual tools)

Ref. picture: "Invisible Worlds exhibition - 2012" by M J Richardson is licensed under CC BY-SA 2.0"

RESOURCES

Resources for activities before and after the SAFE workshops, infographics, audiovisuals, surveys and contacts.

THE ANTIMICROBIAL RESISTANCE

THE DISCOVERY OF ANTIBIOTICS

Antibiotics are natural chemicals that have antimicrobial activity. They are used to **treat infections** in animals and humans. The world we know would not be the same without antibiotics. In 1928 Fleming observed that when **the fungus *Penicillium notatum* spontaneously grew in its bacterial cultures, its growth was inhibited around it.** The success of penicillin promoted the research and discovery of many other antibiotics, and earned Fleming, Chain, and Florey a Nobel Prize in 1945.

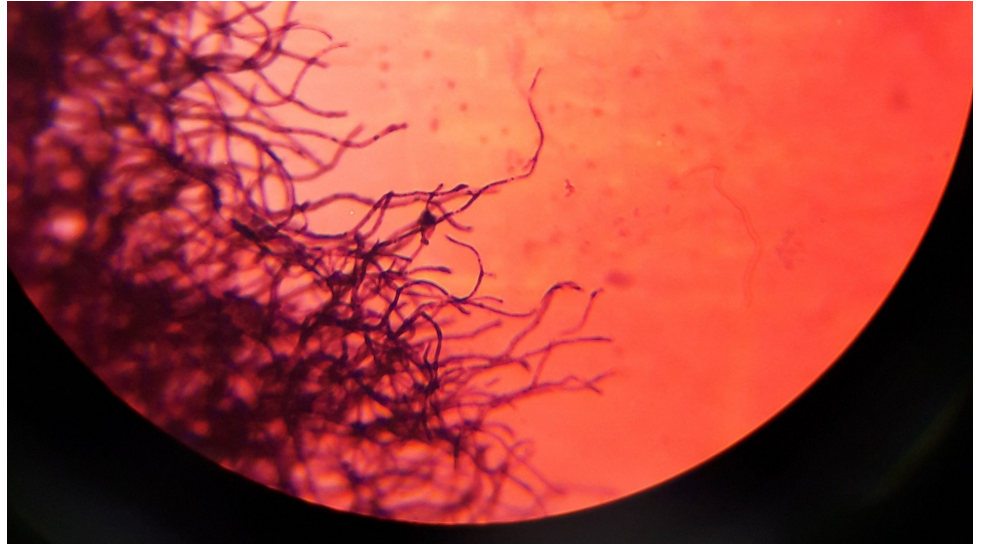
Today, most of the antibiotics we know and use are microbial products.

MICROBIAL ECOLOGY

Seventy years after the introduction of penicillin for clinical treatments, almost all the bacteria that cause serious infections have developed resistance to this drug. **The dream of overcoming the infection that was formulated in the 1950s and 1960s, the "Golden Age of Antibiotics," has faded.**

Microbial Ecology is the **study of microbial interactions with each other and with their environments.** Microorganisms are part of complex ecosystems where hundreds of species communicate with each other, establishing symbiotic relationships. Two of the main topics studied in microbial ecology are **Biodiversity and Bioactivity present in ecosystems.**

THE MICROORGANISMS



Microorganisms are the object of study of Microbiology. **They are any organism that cannot be observed with the naked eye, and therefore, we need a microscope to study it.**

Microorganisms are the **most abundant and diverse beings in nature,** able to adapt to the harshest living conditions of our planet. It includes **Bacteria and Archaea (both Prokaryotes, cell organisms without a nucleus),** but also includes very diverse **microscopic Eukaryotes, such as protozoa, unicellular algae or yeasts and molds (the latter two being fungi).**

Viruses, virions, and prions are also grouped into the general category of microorganisms, but they don't have cellular nature and are strict parasites: they require infecting a living cell to multiply.

Microorganisms colonize all habitats in the Biosphere: from our skin and gut to the seabed or the Antarctic ice. Its diversity is unattainable and scientists are only beginning to unravel it thanks to the most advanced techniques of molecular analysis.

Antibiotics are "chemical weapons" that many bacteria and fungi naturally produce and secrete into the environment to eliminate other competing microorganisms and colonize the habitat more efficiently. Of course, antibiotic producers have an "antidote" that makes the antibiotic they secrete not toxic to them. **That is, nature provides us with antibiotics, but also the mechanisms of resistance that, if acquired by pathogenic bacteria, will become resistant.**

THE ANTIMICROBIAL RESISTANCE

WHAT IS THE ANTIMICROBIAL RESISTANCE (AMR)?

This **last decade** has hosted the **highest global expansion of antimicrobial resistance** since the introduction of antibiotics for the treatment of bacterial infectious diseases.

Resistance is an adaptive response of bacteria to the selective pressure we have subjected them, due to the mass release of antibiotics from the outpatient, hospital and veterinary fields, and their dissemination through the environment.

WHAT CAN WE DO?

1) WASH YOUR HANDS (Spain is one of the 5 countries in Europe with the least habit of washing hands). One of the most efficient measures to prevent infections is to wash our hands every time we return home, or we have come into contact with a possible microbial agent.

2) USE ANTIBIOTICS ONLY WITH MEDICAL PRESCRIPTION. Follow the treatment until the end! Remember that antibiotics only cure bacterial infections, NOT VIRAL ones.

3) RECYCLE EXPIRED ANTIBIOTICS OR THE TREATMENT'S LEFTOVERS. When you finish the treatment with antibiotics, or if you have expired antibiotics at home, take them to the **SPECIFIC** points of the pharmacies and, above all, do not use them for other treatments.

CURRENT CONTEXT

The abuse and misuse of antibiotics and other antimicrobial drugs, promotes the development and spread of resistant microorganisms, and **generates a greater need to administer effective alternative treatments** against these pathogens.

Every year, 33,000 people die in the European Union as a result of infections by multidrug-resistant bacteria (also called superbugs), according to data from the European Center for Disease Control (ECDC). If we focus on the Spanish context, a recent study carried out by the Spanish Society of Clinical Microbiology (SEIMC) indicates that in **Spain alone 29,000 people die each year.**

Moreover, adding severity to the situation, **over the past few decades there has been a steady decline in the number of drugs approved.** Thus, **in the last 30 years they have only been approved, for marketing, 2 new antibiotics worldwide.**

Addressing the current situation of resistance requires **urgent measures to curb the misuse of antibiotics in humans and animals, monitor the emergence of resistant bacteria and develop new therapeutic alternatives**, leading to the direct **involvement of politicians and public bodies with citizen participation and adequate economic investment.**

As the World Health Organization announces, **"Microbial resistance to antibiotics is potentially the most important medical challenge facing humanity in the 21st century.** If no action is taken on this, between today and "By 2050, the cost of antibiotic resistance could exceed \$ 100 billion and the premature death of 300 million people."



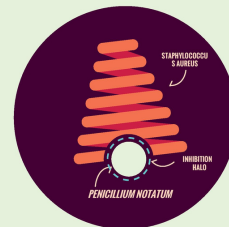
THE ANTIMICROBIAL RESISTANCE

KEYPOINTS TO UNDERSTAND

ANTIMICROBIAL RESISTANCES

1 A LITTLE HISTORY ABOUT ANTIBIOTICS

The first antibiotic was discovered in 1928 by the British scientist Alexander Fleming, it was **Penicillin**, a substance produced by the fungus *Penicillium notatum*.



2 WHAT ARE ANTIBIOTICS FOR?

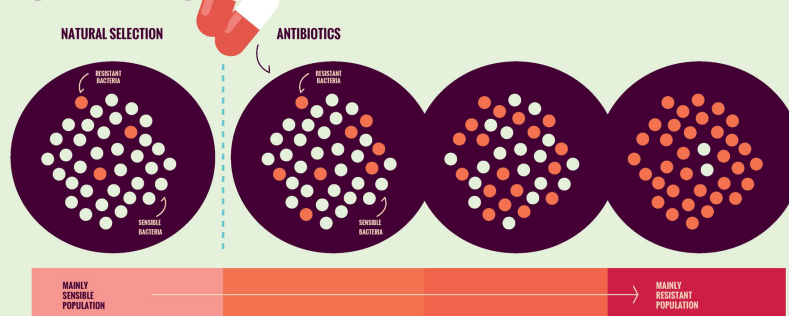
Antibiotics are medicines used to treat infections due to ...

BACTERIA — **VIRUS** — **FUNGI** — **PARASITES**



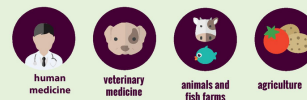
3 WHAT IS THE RESISTANCE TO ANTIBIOTICS?

Es la capacidad de adaptación que tienen los microorganismos para crecer en presencia de los antibióticos.



4 HOW DOES RESISTANCE APPEAR?

Due to a MISUSE and ABUSE of antibiotics in...



5 WHAT ARE THE CONSEQUENCES OF ANTIBIOTIC RESISTANCE?

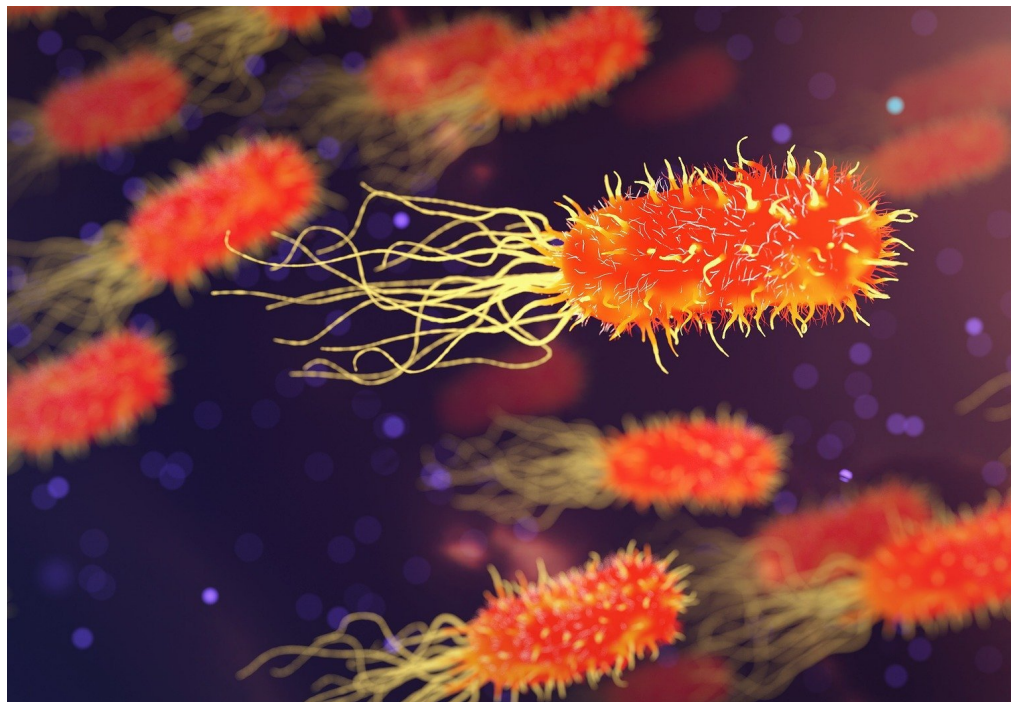
- A. Selection, persistence, and spread of highly resistant bacteria.
- B. High cost of treatment and prevention of infectious diseases.
- C. Acquisition of multi-resistant bacteria by the population.
- D. Every year **700,000 people DIE** from infections due to resistant bacteria.

6 WHAT CAN WE DO TO TACKLE THE PROBLEM?

- A. Only take antibiotics under **medical prescription**.
- B. Even if symptoms improve, **follow the antibiotic treatment until the end**.
- C. Take **hygienic measures** to avoid the transmission of microorganisms.

**THE RESISTANCE IS A PROBLEM FOR ALL OF US
AND YOU CAN HELP REDUCE IT**

KNOWLEDGE AND RESOURCES IN ANTIMICROBIAL RESISTANCE



PREVIOUS ACTIVITIES

RESOURCES TO EVALUATE PREVIOUS KNOWLEDGE

We propose several resources to assess students' level of knowledge in the field of Antimicrobial Resistance and the use of antibiotics, a collection generated by the AMR initiative of ISGlobal and the University of Barcelona.

Kahoot: Questionnaire that will allow to evaluate the previous knowledge of the students in a dynamic and fun way.

Small World Lab Diaries: Videos generated on the Small World Initiative (SWI) method for the Microbiology Society.

KILLER DISEASES: Documentary divided into five episodes created by Doctors Without Borders (DWB). It deals with the history of antibiotics to the reactions of antibiotics in our body and the emergence of resistance.

ONLINE RESOURCES

In order to contextualize students in the field of Antimicrobial Resistance (AMR), we propose the following online resources:

DOCUMENTARY

RESISTANCE FIGHTERS: 2019, Michael Wech, EEUU-DEU. Documentary about the fight of researchers worldwide against the threat of superbugs, which have developed resistance to our antibiotics. VOS.

#EITHEALTHSAFE **SAFEINITIATIVE.EU**

The hashtag and blog presented are specific to the SAFE project, and include publications from students who have participated in the project, news and research in the field of AMR, as well as future events and audiovisual resources.

INFOGRAPHIC 12 PRIORITY **SUPERBACTERIA**

Infographic describing and defining the 12 species of bacteria that are in the top list of research priority, as published by the World Health Organization (WHO).

SAFE, THE PROJECT

STRUCTURE

SUPERBUG AWARENESS FOR EDUCATION

SAFE is an international project that begun to be implemented in January 2020, and this year is hosting its second edition, in the field of antimicrobial resistance.

The main activity of the project follows a **Service-Learning methodology**, where university students who are trained will teach high school students (**training the trainer**), encouraging the vocation for **STEM careers (Science, Technology, Engineering, and Mathematics)** through lab sessions, which will also serve to raise awareness and knowledge on the serious problem triggered by antimicrobial resistance and the search for antibiotic-producing bacteria.

Among other actions, the training of university students is carried out so that they can transfer knowledge to elementary and high school students, and implement research projects in the field of microbiology.

In order to disseminate the project and scientific knowledge to the population, **we will also participate in various festivals and scientific events with workshops for the construction of DIY microscopes, observation of cultures and bacterial colonies, microscopic observation of bacteria and gamification through the game Micro-Combat.**

SAFE actively involves the community in the search for new antibiotics.

Although only large research centers and the pharmaceutical industry have the capacity to study, develop, and exploit the complex chemistry that results from microbial bioactivity. But anyone, in any soil, can find unique microorganisms, with chemical capabilities still unexplored. Thus, researchers have the opportunity to collect hundreds or thousands of samples at very remote locations and test the activity of the microorganisms that inhabit them.

Through SAFE we propose that this time it is the students who take the first step to start the chain of antibiotic discovery, while learning biology, ecology and chemistry. **The questions we seek to answer, are:**

- **How many species of bacteria, present in our soil samples, can we grow?**
- **How can we distinguish one from another?**
- **Are bacteria different in different environments?**
- **Can we detect antimicrobial activities?**
- **Are these environmental microorganisms capable of inhibiting the most feared "superbugs" in our hospitals?**

EUROPEAN CONSORTIUM

SAFE is an international project that gathers a consortium with research institutions, academic entities, and private companies of South Europe (Italy, Spain and Portugal). Our partners, are: ISGlobal, Universitat de Barcelona, Università degli studi de Napoli Federico II, Institut Català de la Salut, Universidade do Porto, Instituto de Desarrollo Profesional, Sociedad Española de Microbiología, Roche Diagnostics SL, Universidad Complutense de Madrid, and Escola Universitária Vasco da Gama

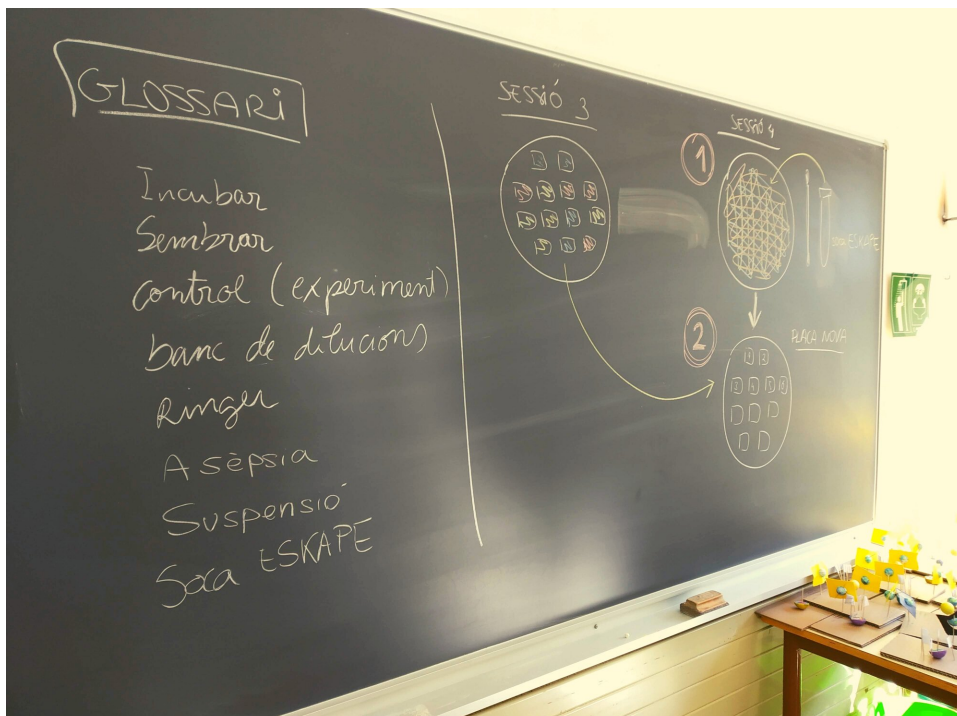
OUR BLOG AND SOCIAL MEDIA

You can find more information about the project, the publications of our team and participants, by following us on social media [#eithealthsafe](#) (Twitter Instagram) and on

SAFEINITIATIVE.EU



SERVICE-LEARNING WORKSHOPS



THE SERVICE-LEARNING METHOD

The L-S activity of SAFE, has its origins in the Small World Initiative (SWI) project that was born at Yale University in 2012. From then on, the SWI movement has spread throughout the USA and beyond, as in the United Kingdom, Ireland, Portugal and Spain. From the 2017/2018 academic year, it started being implemented as part of the Pharmacy Degree at the University of Barcelona

The Service-Learning method, provides **the opportunity to conduct original research rather than conduct guided experiments where results are predetermined. Through a series of experiments designed by the students themselves, they will take soil samples, isolate various bacteria, test these bacteria against clinically relevant microorganisms, and characterize those that show inhibitory activity.**

SAFE's strategy also provides a **platform for the discovery of new antibiotics based on Participatory Science and Crowdsourcing, thus integrating the intellectual potential of many people who compete against this global challenge, by discovering promising candidates for the development of new drugs.** This participatory strategy uses active learning techniques to achieve both educational and scientific goals.

BACTERIAL STRAINS AND STUDENT TASKS

The isolated microbial strains will be conveniently preserved at the University of Barcelona (UB) and will be shared among the SAFE consortium and community.

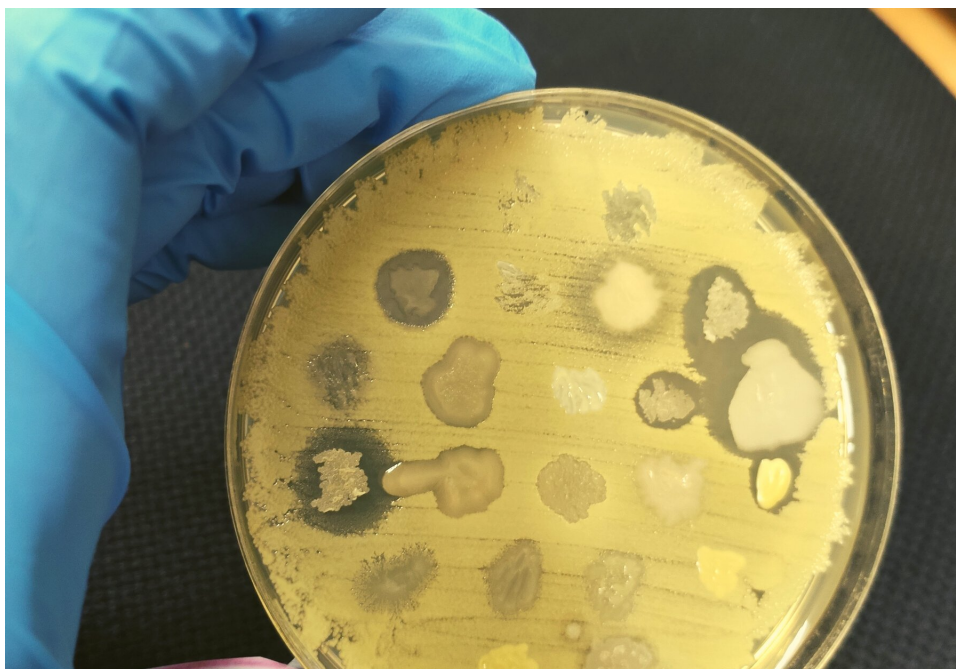
Researchers will make use of these strains with the intention of discovering the chemicals responsible for their potential antibiotic phenomenon, recognizing the origin of the strains within the SAFE framework by all those who have participated in its discovery, including the students and tutors involved.

SAMPLE COLLECTION

Sampling will be done mainly from soil samples, as the vast majority of antibiotics have been discovered from this type of sample. Still, other collection sources can be explored.

SERVICE-LEARNING WORKSHOPS

SERVICE-LEARNING FOR THE STUDENTS



The program focuses on the idea of a **discovery-based Basic Biology course**, in which students from around the world conduct fieldwork and laboratory research on soil samples in search of new antibiotics. This aspect is particularly relevant, **as two-thirds of available antibiotics come from bacteria or fungi isolated from soils.**

DISSEMINATION OF THE RESULTS

SCIENTIFIC COMMUNICATION

SAFE aims to transfer knowledge in Microbiology through L-S workshops and laboratory sessions. It also aims to collect the results (to open future lines of research) and disseminate the importance of scientific communication towards the general public of the obtained results. SAFE students will present their experiments and results through posters, audiovisual resources or articles, on the blog safeinitiative.eu and on the scientific dissemination events in which we participate (Congresses, Science Festivals, fairs, etc.).

OTHER VIDEOS AND RESOURCES

AUDIOVISUALS

[What causes antibiotic resistance?](#)

[How bacteria rule over your body](#)

JUEGOS Y RECURSOS DOCENTES

[e-BUG](#): games and resources in the field of microbes and antibiotics.

ONE HEALTH

The problem arising from AMR entails a planetary health problem, as explained in the graph below.

The concept of "**One Health**" refers to the appearance of resistant bacteria due to the antibiotic's misuse and abuse by humans and animals, transferred to the environment through wastewater, mainly, and spreading everywhere. For this reason, it is a global health problem that requires to take measures considering all of these factors into account.



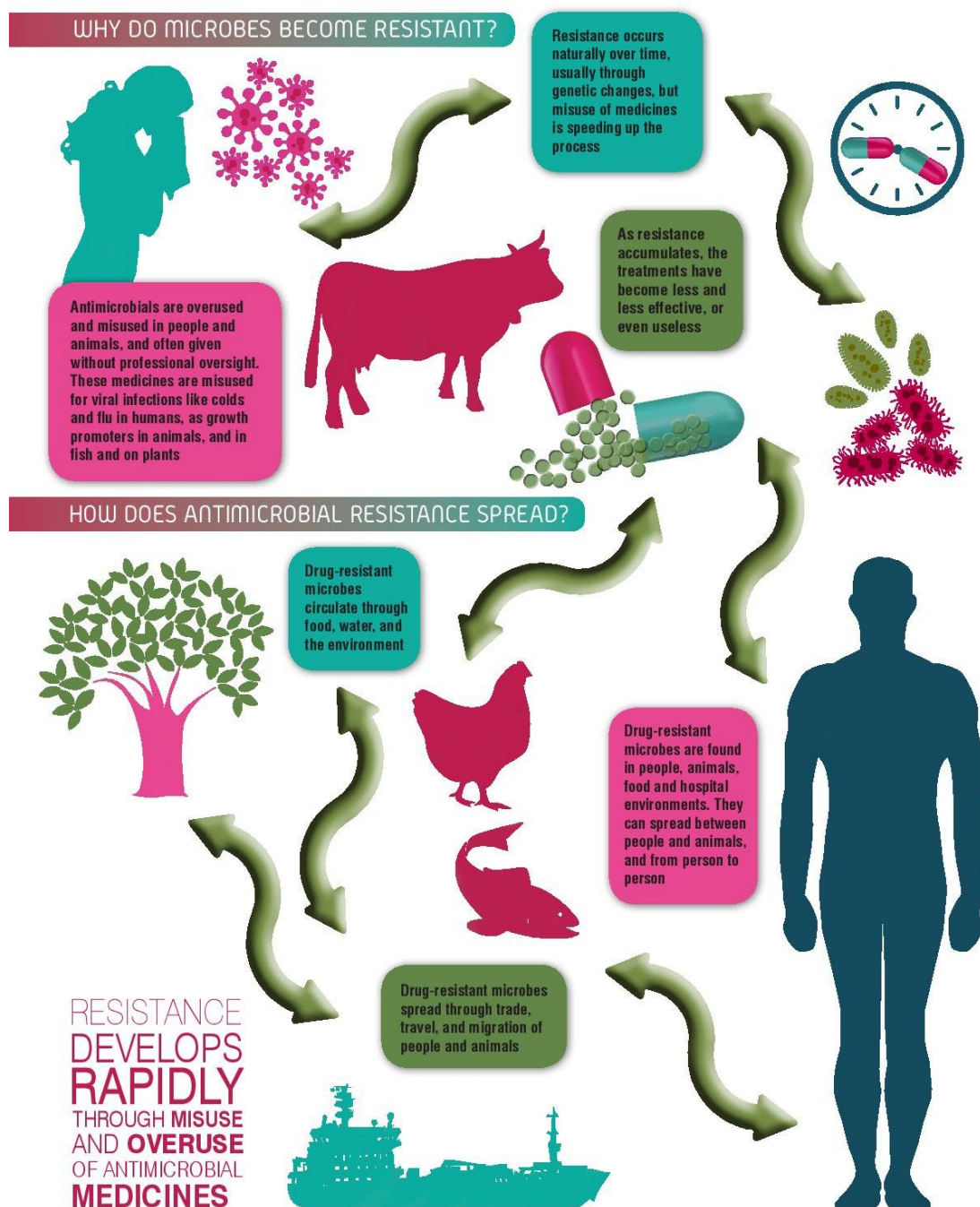
Food and Agriculture
Organization of the
United Nations



WORLD ORGANISATION
FOR ANIMAL HEALTH



World Health
Organization



EVALUATION ACTIVITIES

KAHOOT QUIZZES

KNOWLEDGE EVALUATION

Below, we suggest that students review our blog (safeinitiative.eu). You can find other questionnaires through the following link. It will help us to evaluate the impact of SAFE (anonymous survey):

Questionnaire on acquired knowledge on the field of ARM:

Questionnaire aimed at high school students that have participated in our program. The answers, that will be collected anonymously, will help us on evaluating the impact of SAFE and will be forwarded to the responsible teachers of each class.

KNOWLEDGE EVALUATION

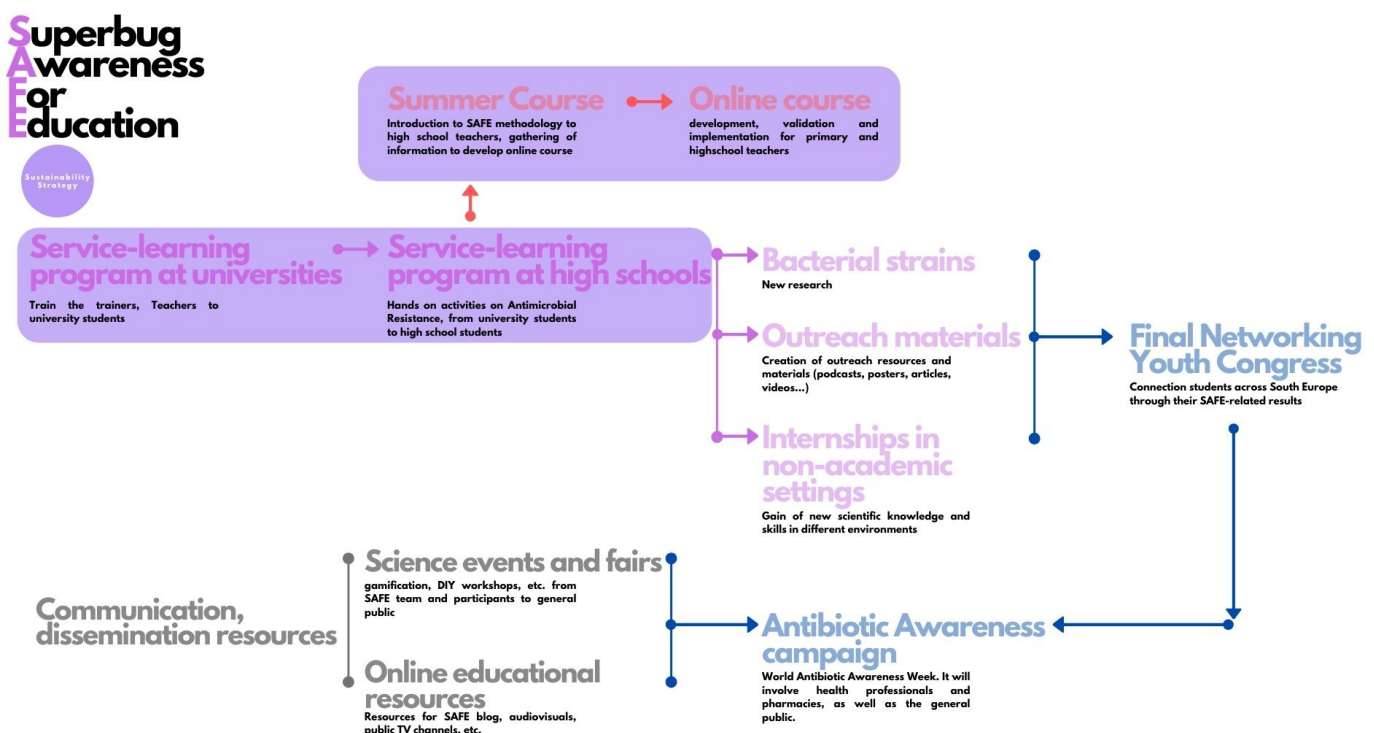
The presentations will be useful to evaluate the L-S method and to increase the impact it has had among the students.

To present the results, you can generate scientific posters, videos, podcasts, or articles, which will be posted on the safeinitiative.eu blog after being reviewed by our expert team.

CO-CREATION CAMPAIGN

Do you want to participate in the co-creation of an awareness campaign? You can fill in your intrigues, confusions, or interests in the field of antimicrobial resistance by visiting our blog or reaching us out in our outreach events!

You will help us to create an awareness campaign on Antimicrobial Resistance, which will be launched throughout South Europe next November, as part of the World Awareness Week on the Use of Antibiotics!



INCENTIVES AND OTHER RESOURCES

SCIENCE FESTIVALS

Conferences and outreach events for scientific dissemination, in May, of all the research collected by the University of Barcelona. It will be hosted both online and offline.

[HELP US TO BE SAFE!](#)

[Visit our website and get to know in which festivals are we going to be!](#)

WAAW AND EUROPEAN RESEARCH NIGHT

GAMIFICATION IN ANTIMICROBIAL RESISTANCE

Moreover, the participants will be able to introduce their experiences and experiments in Science Festivals in Barcelona, Naples, Coimbra and Oporto, and in international festivals such as the Research Night, World Antibiotic Awareness Week and others, where the students will get to know other participants of SAFE.



MICRO-COMBAT

We introduce you now the game Micro-Combat. It is a collaborative game where players will be able to place themselves as medical personnel and will have to protect the population from the attacks of the pathogens that threaten the city.

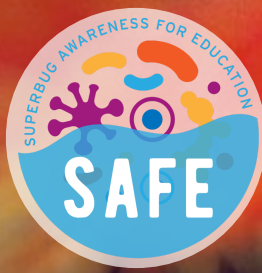
In order to protect them, players must correctly use the prevention and treatment tools they have at their disposal. They need to be careful as some pathogens may become resistant to drugs and therefore cannot be treated.

In a playful way, then, players end up becoming familiar with the various types of pathogens (bacteria, viruses, protozoa and fungi) and the diseases they cause, the multiple routes of transmission, the specificity of drugs to fight infections and the phenomenon of pathogen resistance to treatments.

The game was conceived by ISGlobal in collaboration with the Laboratory of Games and was produced thanks to funding from the European Health Forum Gastein and the European Awareness Day, an initiative of the ECDC (European Center for the Control of Diseases). Micro-Combat has been awarded as the best communication initiative by the Spanish Medicines Agency.

You will find the game available at eltroquel.es for € 12, the earned profits will go entirely to ISGlobal's Antimicrobial Resistance research. (more information about the game at www.isglobal.org/micro-combat).

You will find available the App version of Micro-combat, for free, at: microcombat.eu



Partial translation and adaptation made by the SWI@UCM, UB and ISGlobal team, based on the original material in english by @Simon Hernandez, Tiffany Tsang & Jo Handelsman. The adaptation and subsequent modifications have been made by the SAFE team.

[Check more information at: safeinitiative.eu](http://safeinitiative.eu)



SAFE

SUPERBUG AWARENESS FOR EDUCATION