Education Package for Battle for Cattle

This lesson is addressed to high school students aged 14-16 years old.
The whole activity lasts from 2-3 hours. It can be divided in different sessions.
No specific material is needed. All the resources are included in the teaching guide.

Game and PowerPoint presentation are available for this lesson.
Do not hesitate to adapt the lesson to the knowledge of the students.

IMPORTANT TOPICS & KEY QUESTIONS appearing in the game:

Give an introduction to the basic biological themes

- What is a bacteria? What is a virus? What are the differences between them?
- How do we cope with infections?
- What are antibiotics?
- What is antibiotic resistance?
- What is a vaccine?
- What is synthetic biology?
- How is a synthetic biology vaccine made?

LEARNING GOALS

- Bacterial infections can be treated with antibiotics
- Bacteria can grow resistant to antibiotics
- Viral infections cannot be treated with antibiotics
- Vaccinations protect from viral & bacterial infections
- Synthetic biology is a multidisciplinary area of research, where new biological parts and systems are constructed, and existing biological systems are re-designed.
- To make a synthetic biology vaccine you need antigens and a harmless host. It is created by removing unnecessary DNA from a bacterial host - creating a chassis - and inserting DNA coding for epitopes (characteristic surface elements) of the pathogen
- Promote and develop critical thinking
- Learn through play
- Learn about the social implications and impact of vaccines
- Learn how to argue and respect diversity of opinions
- Understand the benefits of vaccination

GUIDE FOR THE LECTURE

Introduction – Slide 1 to 7

Slide 1: Title page

Slide 2: Explain the planning of today: an introduction, a game to play, and a discussion on the learning goals.

Slide 3: Explain what bacteria are, highlighting that not all bacteria are pathogenic and some are even necessary elements of the human body physiology. In our body, we have

trillions of bacterial cells. In fact, it is estimated that there are ten times more bacterial cells in the body than human cells. All this bacteria, together with other one-cell microorganisms, form the microbiome.
Organisms from the microbiome are crucial to help digestion, support the development of the immune system, and prevent infections among other functions.

Slide 4: Explain what viruses are. Continue by asking how we can treat the different infections. Depending on the students' level of understanding an answer as 'medication' can be satisfactory, with older students, continue asking and see if they come up with antibiotics and vaccines.

Slide 5: Ask what the main differences between antibiotics and vaccines are. Antibiotics can treat you, vaccines prevent you from a specific disease.

Slide 6: Explain how antibiotic resistance develops. Ask why the overuse of antibiotics might backfire. Explain how antibiotic resistance can occur.

Slide 7: Explain what synthetic biology is and where it is used.

Optional: **Youtube videos 1 & 4 may help remembering and illustrating this introduction part (see below, description of the videos)**
Students may also watch the videos after school, to reinforce what they had learned.

Main part – Slide 8 to 10

Slide 8: Play the game (depending on the length of the lesson; about 30 minutes, after the lesson they can finish it).

Slide 8: Ask what the students think about the game. What was difficult?

Slide 9: Discuss about the antibiotics used in the game. What kinds of problems were encountered? Ask students if they know why the antibiotics stopped working after a while. (The desired answer is antibiotic resistance). Also, discuss about the effect of antibiotics on our own microbiota and the consequences for our health. Antibiotic treatment acts on bacteria causing infection but also affects up to 1/3 of the resident microbiota decreasing the number of different species, diversity and evenness of the bacterial community.

Slide 10 & 11: Discuss how the vaccine chassis is made. Remove any harmful genes from bacteria and put in the genes coding for the epitopes of the pathogen. Depending on the knowledge of the students, further information on epitopes, antigens and antibodies can be given. Ask what is important in making a vaccine. The desired answers are: a harmless host (pneumoniae, bacteria) and antigens from the pathogen.

Slide 12: Discuss the immune system according to the respective knowledge level. Ask if anyone knows how and why a vaccine works. Explain what the function is of the antigens and how they train the immune system and the immune memory.

Discussion – Slide 13:

Slide 13: Discuss all the **learning goals** and answer questions. The discussion can be opened up to related topics, suggestions are listed below (topics for additional discussion).

Music Video Clip about the MycoSynVac project – Slide 14:

If time left, show MC Grease video (Click the image to play the video or the link below).
https://www.youtube.com/watch?v=uY60ijZZX1o

(video clip in English with English subtitles, but youtube also offer translation of those subtitles in Spanish and Catalan)

It is a fun music video clip that features the video game characters and further explains the European project MycoSynVac (Collaboration of 7 European research centres whom objective is to develop a broad-spectrum vaccine to fight bacteria infection in farm animals – More information on the project website)

Additional material: youtube video on the different biological concepts – Slide 15:
To help teaching the basic biological notions in the introduction, you could use some of these suggested youtube videos (see below, description of the videos). **We recommend watching the video of interest beforehand to ensure that students will understand them and/or to select the part of video that will best fit your teaching lesson.**

(video clip in English with youtube English subtitles options, and translation of those subtitles in Spanish and Catalan)


Click on this icon to add subtitles to the video


Click on this icon to choose the languages of the subtitles

Additional material: Graph showing the impact of vaccination on human global health – Slide 16:

Graph that shows the importance of vaccination, and gives statistical data proving that vaccines do indeed work.

This graph shows that, from 1990 to 2017, the decline in child (< 5years) deaths which are not vaccine preventable has been modest, while the number of child deaths caused by diseases for which vaccines are available declined from 5.1 million deaths in 1990 to 1.8 million deaths.

Statistical data are powerful tools to use in a discussion on the benefits and risk caused by vaccination

Additional material (optional): Play decide the discussion game – Slide 17:

To help consolidate, in a fun way, all the information student have learnt, you could use the tool: **The PlayDecide discussion game** that allows to talk in a simple, respectful and fact-based way about controversial issues. All the instructions and materials can be found in the website.

The game enables players to get familiar with a question, see it from different perspectives and form or clarify their own opinion.

For discusssion around vaccination
See the pdf: "Vaccines, key tools for prevention" that contains all the necessary elements for a group of up to 8 people.

Youtube video 1, 2 & 3 may help preparing this game (see below, description of the videos)

For discusssion around genetic engineering
See the pdf: "Genome Editing" that contains all the necessary elements for a group of up to 8 people.

Youtube video 4 may help preparing this game (see below, description of the videos)

TOPICS FOR ADDITIONAL DISCUSSION:

- **What are the arguments in favour and against vaccination in animals and humans?**

In favour: From an individual point of view, once vaccinated most people develop a long or even permanent protection against the disease. By getting a vaccine first, the risk of getting the disease is reduced and one can stay healthy. It reduces suffering, both in humans and animals. From the point of view of the whole population, vaccines help to reduce the risk of an epidemy, that is when a disease affects a large part of the population. Moreover, a high ratio of vaccination contributes to the public health protecting the more vulnerable collectives that cannot be vaccinated. Examples of these collectives are immunosuppressed patients, newborn children, pregnant women or people allergic to a specific vaccine. If an epidemy happens, it can cause parts of the economy and infrastructure to fail (e.g. when most policemen, firefighters, doctors etc. become sick) causing damage to other people as well.
Vaccine-preventable diseases have been a major cause of illness, death, and disability throughout human history. The advent of the modern vaccine era has changed this significantly; most North Americans and Europeans have little memory of a pre-vaccine era where diseases such as mumps and measles — to say nothing of smallpox or polio — were common and often deadly.
In farm animals vaccination helps the farmer to protect their animals and also to plan and calculate the revenue, since the risk of loss or delay in production (egg, milk, meat) is largely under control. Vaccination in animals is also good for humans, since some diseases can spread from animals to humans, e.g. salmonella. In some cases vaccinations can help to reduce the use of antibiotics in farm animals. In some cases a disease that afflicts farm animals because of no vaccination, may also spread to wild animals, such as from pig to boar. In the case of the African Swine Fever unfortunately no vaccine exists yet. As so many pigs have died from the disease, some governments ordered the shooting of wild boar for stopping the transmission of the virus to and from pigs.

Against: Vaccines cost money, and from an individual point of view this is similar to an insurance, one never knows whether a disease is going to affect you so maybe you will get sick or you will not get sick. In case you will get sick having been vaccinated is of course good, but if you don't get sick then the protection was done without needing it. The point is that it is uncertain if you will be affected by a disease, over the long run though you might get another one some other time. Also because of the way the vaccine works as a protection, you cannot get the vaccine AFTER you get the infection, only before!

In some cases the vaccine itself may cause mild forms of immune reactions, like a fever. Only in rare cases the immune reaction is very strong. Some forms of vaccines (live vaccines) should not be applied when a woman is pregnant. Vaccines using dead infectious agents can be used in the second and third trimester of the pregnancy, but in the first 3 months of the pregnancy a doctor should be consulted. If you think you are pregnant or planning to become, please tell your doctor before a planned vaccination.
Also the protective immune reaction works best when the person (or animal) is in good general health, while sick from another disease a doctor should be consulted to maybe postpone the vaccine for later.
Another important point to take into account is the mutational variability of the viruses, because this questions the effectiveness of vaccines; in some cases, the viruses mute annually, and the vaccines are designed from the virus of the previous year.

Youtube video 2 may help discuss on this topic (see below, description of the videos)

- **How are vaccines administered?**

Vaccines can be administered with a syringe, either under the skin or into the muscle, but in some cases there are also oral vaccinates, where the vaccine is swallowed (e.g. on a cube of sugar).
A microneedle approach, which is still in stages of development, uses "pointed projections fabricated into arrays that can create vaccine delivery pathways through the skin.
There are also needle-free systems: A stamp-size patch similar to an adhesive bandage contains about 20,000 microscopic projections per square cm. This dermal administration potentially increases the effectiveness of vaccination, while requiring less vaccine than injection.
With animals there is also a intradermal vaccination using a high pressure vaccination gun or "jet injector" that shoots a tiny jet of liquid through the skin. (https://en.wikipedia.org/wiki/Jet_injector)
Humans and large animals receive the vaccine by a doctor or a veterinary. In case of small animals (such as fish for aquaculture) the vaccination is done by special purpose vaccination machines that can vaccinate up to 20.000 fish per hour. https://www.youtube.com/watch?v=LF39sNZlLmk
Also for chicken, the vaccination is best delivered when the chick is still inside the egg, resulting in so called in-ovo vaccination. (https://www.youtube.com/watch?v=BnM-dQXlcgo)
While large animals, like cows or pigs are vaccinated e.g. by a jet injector.

- **What is the anti-vaxxer movement?**

The anti-vaccinationists are people who do not want themselves or their children to be vaccinated. Therefore the compulsory nature of vaccination (in some countries and for some diseases) is perceived as a violation of their freedom of choice. The anti-vaccination movement believes that the medical practice of vaccination is responsible for a wide range of health problems. The movement that comprises few medics or scientists bases its claims largely on alleged short- and long-term side-effects of vaccinations. Effects which are often trivial when compared to the severity of what were once common illnesses. Moreover, a

decrease in vaccination could directly be responsible for the return of health disaster by reinvigorating diseases that had almost been eradicated by said vaccines.
The anti-vaccination movement operates mainly in social media.

- **How is Europe trying to promote vaccination?**

Despite the availability of safe and effective vaccines, lack of access, misinformation, complacency towards disease risks, diminishing public confidence in the value of vaccines […] are harming vaccination rates worldwide.

TEN ACTIONS TOWARDS VACCINATION FOR ALL

1.	Promote global political leadership and commitment to vaccination
2.	Ensure all countries have implemented national immunisation strategies that are financial sustainable
3.	Build strong surveillance systems for vaccine-preventable diseases
4.	Tackle the root-causes of vaccine hesitancy & increasing confidence in vaccination
5.	Strengthen the monitoring of the performance of vaccination programmes
6.	Sustain research efforts to continuously generate data on the effectiveness and safety of vaccines
7.	Investment in research, development and innovation for new or improved vaccine and delivery devices
8.	Mitigate the risks of vaccine shortages through improved vaccine availability monitoring
9.	Empower healthcare professionals and the media, to provide transparent and objective information to the public and fight false and misleading information
10.	Align and integrate vaccination in the global health agendas, through a renewed Immunisation agenda 2030

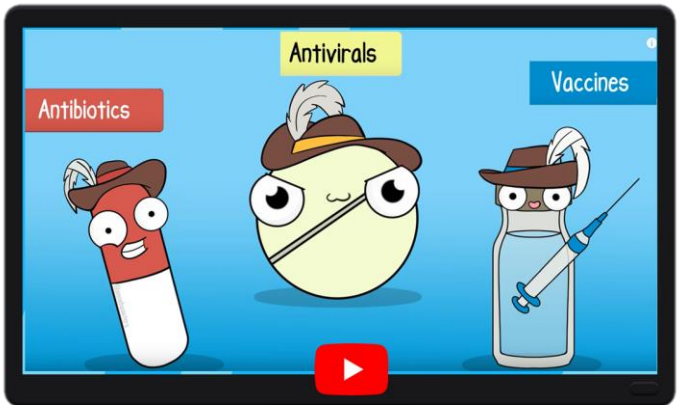
Youtube video 3 may help discuss on this topic (see below, description of the videos)

Moreover, for more detailed information visit this website

DESCRIPTION OF THE VIDEOS:

Youtube video 1: the difference between vaccines and antibiotics

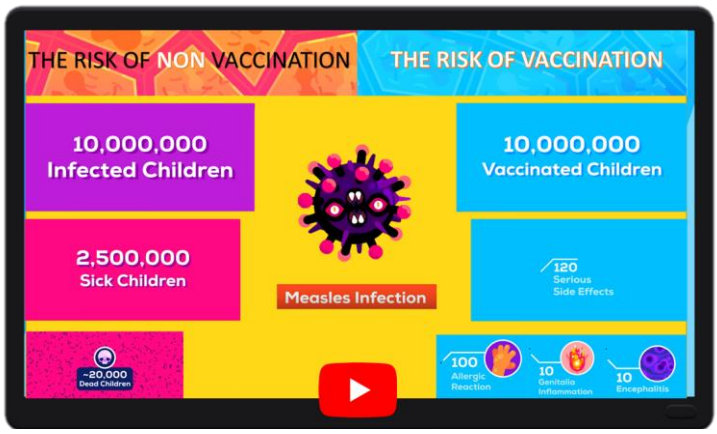
follow this link



Description: cartoon video (9min-relatively easy to understand) that gives **basic notion on antibiotics, Antivirals and Vaccines. How they works, the difference between them, how they are administered (2'42 to end of the video)**… Also gives basic knowledge on the immune system (from beginning to 2'42), the microbiota and its role in the immune system, the herd immunity, the challenge virus mutation in designing new treatments…
This video has no subtitles in Spanish nor Catalan.

Youtube video 2: the risk of vaccination compared to the risk of non-vaccination on human health

follow this link



Description: cartoon video (10min- relatively easy to understand) that describes the impact of vaccination and non-vaccination on the global health of human population. It introduces the human immune system. It describes how vaccines works, **the side effect and impact of vaccines on human health and compares the beneficial impact of vaccination and the potential negatives effects of non-vaccination on global population, explain the examples of measles vaccination (from 3'45 to end of the video)**
This video has the subtitles in Spanish.

Youtube video 3: European vaccine action plan

follow this link

Description: cartoon video (4min- may be difficult to understand) that explain the 5 main objectives that European Union wants to reach in order to strengthen vaccination in Europe: Obj. 1: All countries commit to immunization as a priority; Obj. 2: Individuals understand the benefits of vaccination; Obj. 3: Everyone should have access to vaccines, reduce inequalities. Obj. 4: Support health national program and their vaccination plan. Obj. 5: Ensure affordable price for vaccines & countries get access to latest discoveries.
This video has the subtitles in Spanish.

Youtube video 4: Synthetic biology explained

follow this link

Description: video (4min-realitively easy to understand) that explain what is DNA, how we can edit or re-design it (genetic engineering). Explain what is synthetic biologic and gives example of its use by humans. Also mention the potential negative impact of synthetic biology.
This video has the subtitles in Spanish.

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