Partnerships for Science Education

Vaccines development and the science that responds to hesitancy

Learning Activities and Learning Objects

Project Number: 101006468

Project Acronym: PAFSE

Project title: Partnerships for Science Education

VACCINES DEVELOPMENT AND THE SCIENCE THAT RESPONDS TO HESITANCY

LEARNING ACTIVITIES and LEARNING OBJECTS

Ernest Board (1877-1934).

CONTENTS

Vaccines development and the science that responds to hesitancy
Learning activities and Learning Objects

Subject: Biology (possible contribution of Computer Science, Home Economics, Art, English teachers, etc.)

Grade: 9th grade (+/- 14-15 years old students)

Estimated duration for scenario implementation:

- 5 periods of 40-45 minutes to promote conceptual and epistemological understanding related to the PAFSE topic: *Looking out for my community: Vaccines development and the science that responds to hesitancy.*

- 4 periods of 40-45 minutes to conduct the research project entitled*: How science responds to vaccines hesitancy*.

- Open Schooling Event.

Classroom organisation:

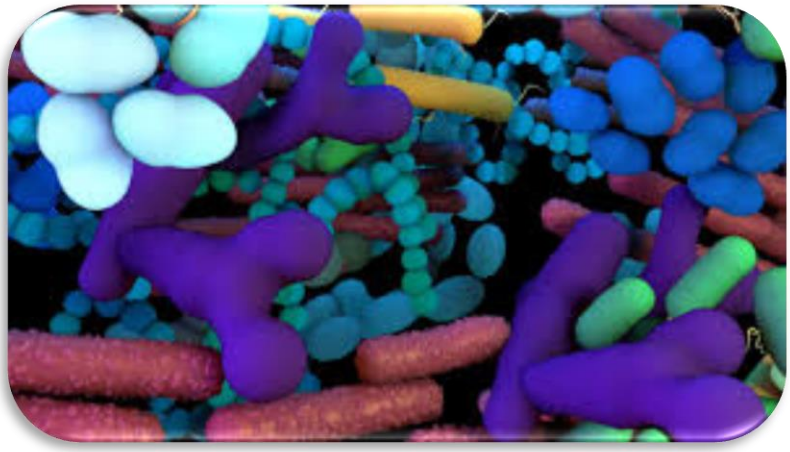
Lessons 1-5: Students are organised in groups of 4-5 students. Use of individual and cooperative learning, discussion, and reflection in the whole class.

Lessons 6-9: Organising students into groups of 4-5 students. Use of cooperative and individualized learning and use of the jigsaw technique. Discussion and reflection in the whole class.

0. Introduction: Vaccines development and the science that responds to hesitancy (lesson 1)

01. Socio-scientific issue

Watch a video related to the Spanish flu 1918, entitled *The Spanish flu: the biggest pandemic in modern history* at https://youtu.be/4H2S97URb_w and then try to do the posed activities.



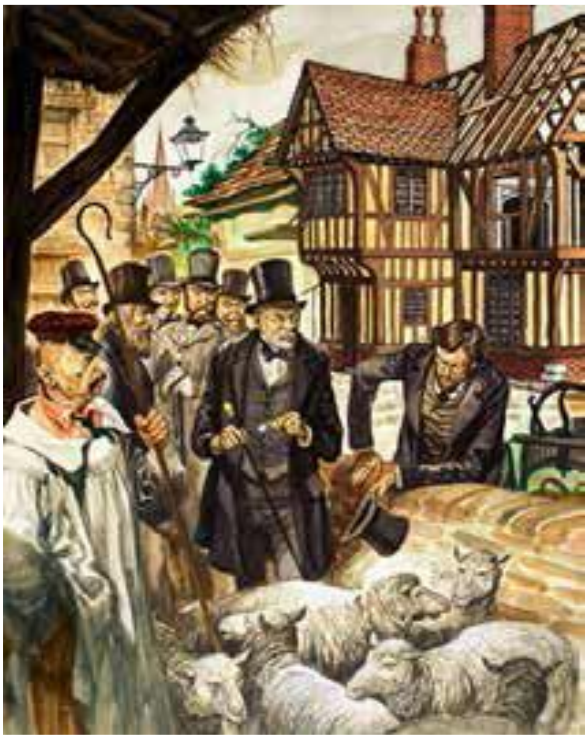
Recently, a new virus has spread around the world, which has caused a lot of businesses to shut down and schools to close to limit the spread. Many pharmaceutical companies try to develop a vaccine that passes rigorous approval tests. One vaccine candidate has passed all these tests, but it has a low efficacy rate of around 50%, meaning that a person who is vaccinated is only half as likely to get sick from the real virus, then a person who is not vaccinated.

The pharmaceutical company argues that the vaccine should be distributed anyway, so that people can be protected, and life can get back to normality. The government people also agree because they want the economy to improve. On the other hand, public health workers are concerned that if a vaccine that has such low efficacy is distributed, people may relax their other preventative behaviours such as avoiding large social gatherings or wearing masks. They are, particularly, worried because a lot of people have signalled that they are afraid to get vaccinated at all. ***Should a low efficacy vaccine be released to the public?***

02. Students' Mission

Your mission is to investigate the following primary research questions:

1. How do vaccines influence the progress of an epidemic and a pandemic?
2. What are the local community's perceptions and knowledge concerning immunity and vaccination?
3. Should a low efficacy vaccine be released to the public? (Debate based on the above socio-scientific issue)



Louis Pasteur (1822 - 1895 a.c.)

Pasteur developed the overall principle of vaccination and contributed to the foundation of immunology.

To answer the above primary research questions related to vaccines, you are asked to formulate specific questions and hypotheses, to collect data from a variety of inquiry-based sources (e.g., such as texts, articles, pictures and videos, tables and diagrams, scientific measurements, questionnaires, interviews, etc), analyse, make inferences, synthesize, and draw conclusions. You will also experience how scientists usually work, as scientific work does not only include conducting experiments but also includes searching for data, evaluating sources and making scientific models.

During this process, you will obtain a basic conceptual understanding of Microorganisms (microbes), Pathogens, Infection, Infectious diseases, Diseases, Epidemics, Pandemics, Antigen, Immune system, Immune response, Antibodies, Immunity, Immunization, Vaccines. Yet, you will be able to explain why vaccines are important for the promotion of public health. Additionally, you will develop the ability to construct different types of arguments, counterarguments, and rebuttals (counter-counterarguments) to debate the socio-scientific question: *Should a low efficacy vaccine be released to the public?*

Finally, through these procedures, you will be able to create a scientific presentation, a brochure and hold a public event (open schooling event) for discussion and debate entitled *Vaccines development and how science responds to hesitancy*. The public event will be organised and coordinated by you, in cooperation with your teachers and the principal of your school.

03. Prior knowledge: Answer the following questions.

01.1. What do you know about microbes?

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01.2. What is an infectious disease?

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01.3. What others infectious diseases do you know (except flu)?

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01.4. What is the impact of infectious disease on society?

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01.5. How do infectious diseases affect the world?

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01.6. What is a vaccine? Why the use of vaccines is defined as a socio-scientific issue?

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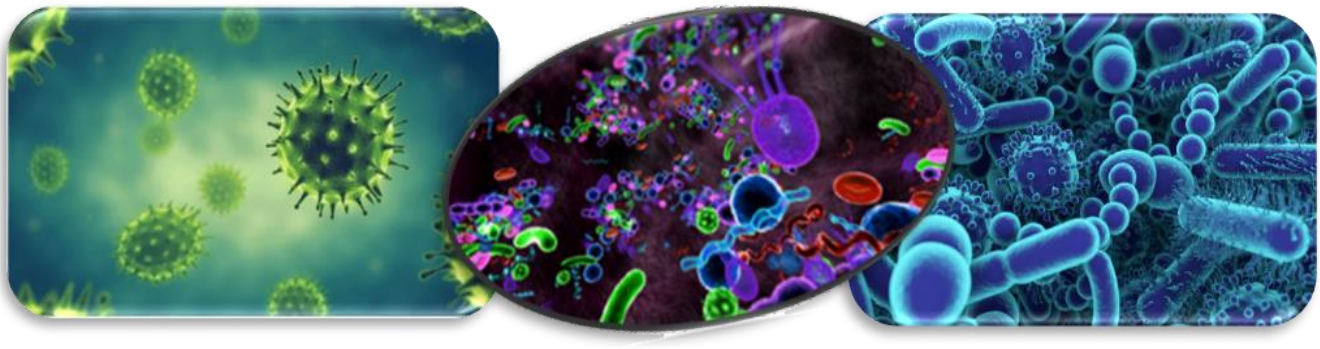
It does not matter if you do not know exactly the answers to these questions. The main objective of doing this activity is reorganizing your initial ideas about microbes and vaccines until now. In the next units you will learn more about microbes and vaccines.



Activity 1: Pathogens and diseases (Lessons 2 & 3)

1.1. Watch the video entitled Pathogens at https://youtu.be/wUm71FPuVCQ , discuss with your group the information of the video, and then answer, in writing, the posed questions**:**

1.1.1. Write if the following statements are true or false and then discuss with your group your answers.

i. All microbes are tiny. _____

ii. The terms 'microbe' and 'microorganism' are synonymous. _____

iii. Microbes are only in the food we eat. _____

iv. All microbes cause diseases. _____

v. Microbes can be useful, harmful or both. _____

vi. There are two types of microbes: bacteria and fungi. _____

1.1.2. Match the constructs of column 1 and the sentences of column 2 to understand better the relation between microbes and diseases.

No	Column1	Column 2	No
1.	Microbes	Diseases caused by microbes that can be passed to or among humans by several methods.	**A**
2.	Pathogens	Diseases that are not caused by pathogens.	**B**
3.	Disease	Diseases transmitted from one person or animal to another.	**C**
4	Infectious diseases	Diseases that can't be directly transmitted between people.	**D**
5.	Non- infectious diseases	A state in which a function or part of the body is no longer in a healthy condition and is characterised by specific signs or symptoms.	**E**
6.	Communicable diseases	Disease-causing microbes	**F**
7.	Non-communicable diseases	Microscopic organisms, including bacteria, viruses, protozoa, algae, and fungi. Although viruses are not considered living organisms, they are sometimes classified as microorganisms.	**G**
8.	Epidemic	A disease outbreak that affects many people in a region at the same time.	**H**

1.1.3. Why do infectious diseases that in the past were usually confined to a single region now spread easily around the world? Discuss your views in your group and explain your reasoning in writing.

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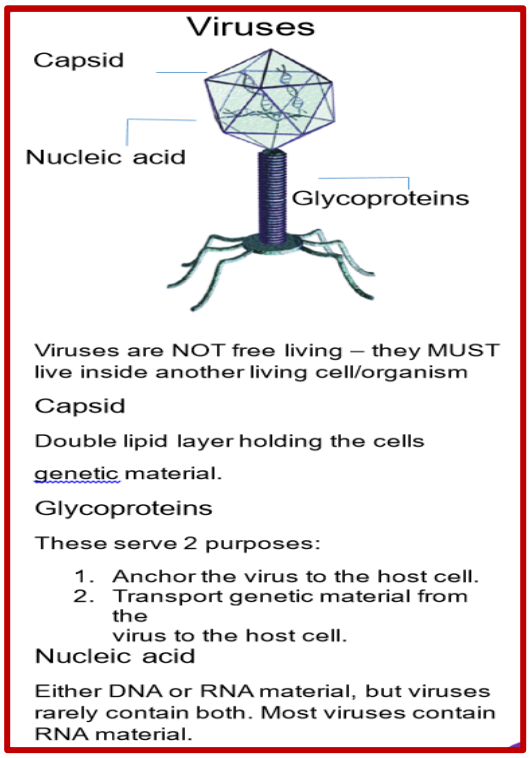
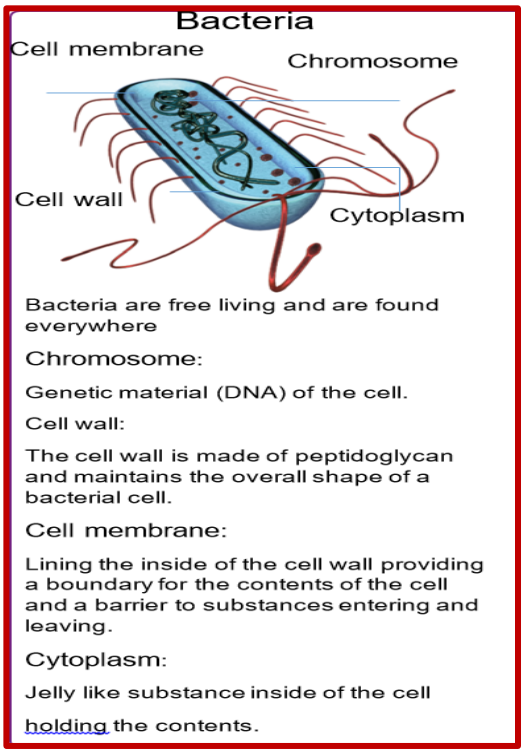
1.1.4. Match microbes and their way of transmission of column 1 and the infectious diseases with their symptoms of column 2 to learn more about microbes and diseases.

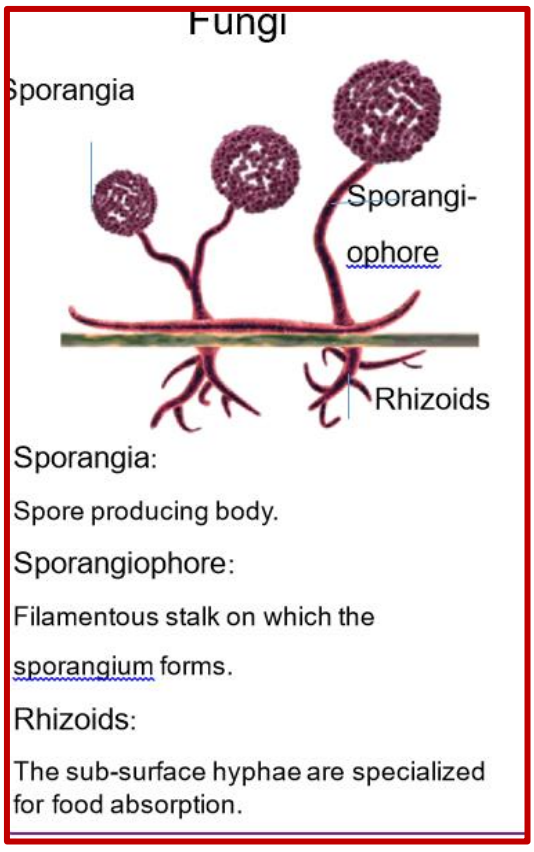
No	Column 1 Microbe and Transmission	Column 2 Infectious disease and symptoms	No
1.	Salmonella bacteria. Contaminated food or food prepared in unhygienic conditions.	Malaria. Fever, moderate to severe shaking chills, profuse sweating, headache, nausea, vomiting, diarrhoea and anaemia.	**A**
2.	HIV (Human Immuno-deficiency Virus). Exchange of bodily fluids and breast milk from infected mother.	Methicillin Resistant Staphylococcus aureus (MRSA). Skin infections, infect surgical wounds, the bloodstream, the lungs, or the urinary tract in previously ill patients.	**B**
3.	Neisseria gonorrhoeae bacteria. Sexually transmitted.	Measles. Red rash and fever often greater than 40 °C (104 °F).	**C**
4	Corona virus. Droplet transmission.	Influenza (Flu). Fever, runny nose, sore throat, muscle pain, headache, coughing, and fatigue.	**D**
5.	Protist: Plasmodium parasites. Vector- Mosquito.	Gonorrhoea. Early symptoms include yellow/green discharge from infected areas and pain when urinating.	**E**
6.	Influenza virus. Droplet transmission.	COVID-19. Fever or feeling feverish/having chills · Cough · Shortness of breath or difficulty breathing · Fatigue (tiredness).	**F**
7.	Measles virus. Inhalation of droplets from sneezes and coughs.	AIDS Acquired Immune Deficiency Syndrome. Early - flu like symptoms. Later - immune system so damaged that get infections easily.	**G**
8.	Bacterium: Staphylococcus aureus. Direct skin contact.	Salmonella. Fever, abdominal cramps, vomiting and diarrhoea.	**H**

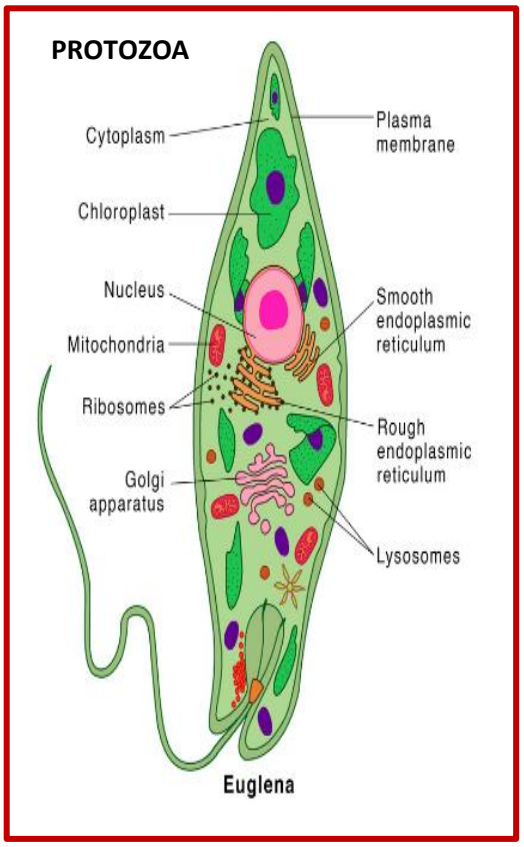
1.2. Microbes are living organisms too small to be seen with the naked eye; they are microscopic. Micro-organisms are found almost everywhere on Earth and can be both useful and harmful to humans. The groups of microbes covered here are viruses, bacteria, fungi, and protozoa (http://www.e-bug.eu/).

Observe the following pictures and try to explain, in writing, the posed questions.









1.2.1. It is important to clarify that microbes are not innately "useful" or "harmful": Discuss with your group the meaning of this statement. Explain your reasoning.

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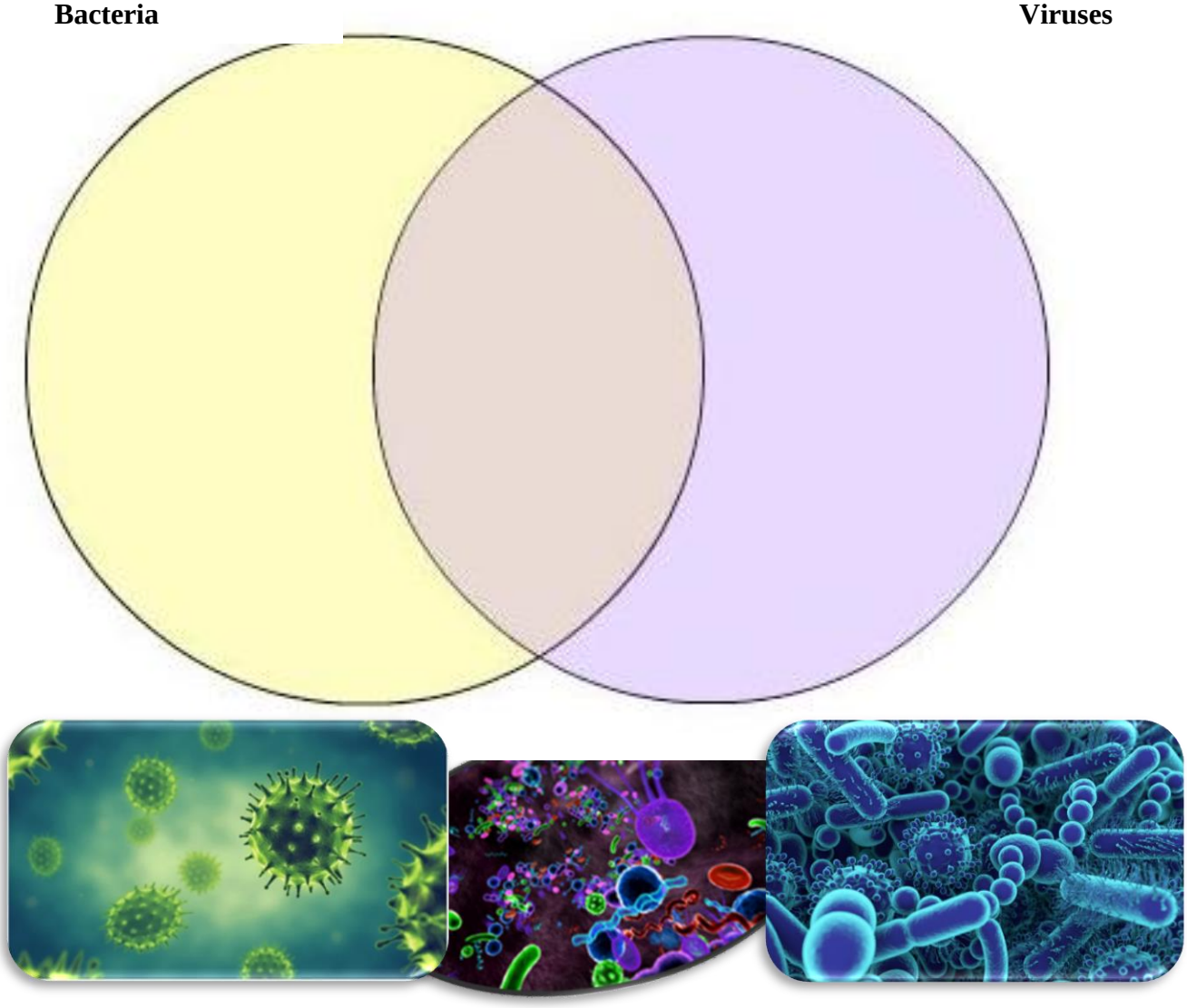
1.2.2. Watch the video entitled Microbes size at https://youtu.be/h0xTKxbIElU and then complete the diagram below, using the terms: bacteria, monocellular fungi, protozoa, viruses.

1.	**2.**	**3.**	**4.**
Size: 1nm	**Size: 1µm**	**Size: 300 µm**	**Size: 1mm**

https://archeia.moec.gov.cy/sm/41/viologia_c_gymn.pdf

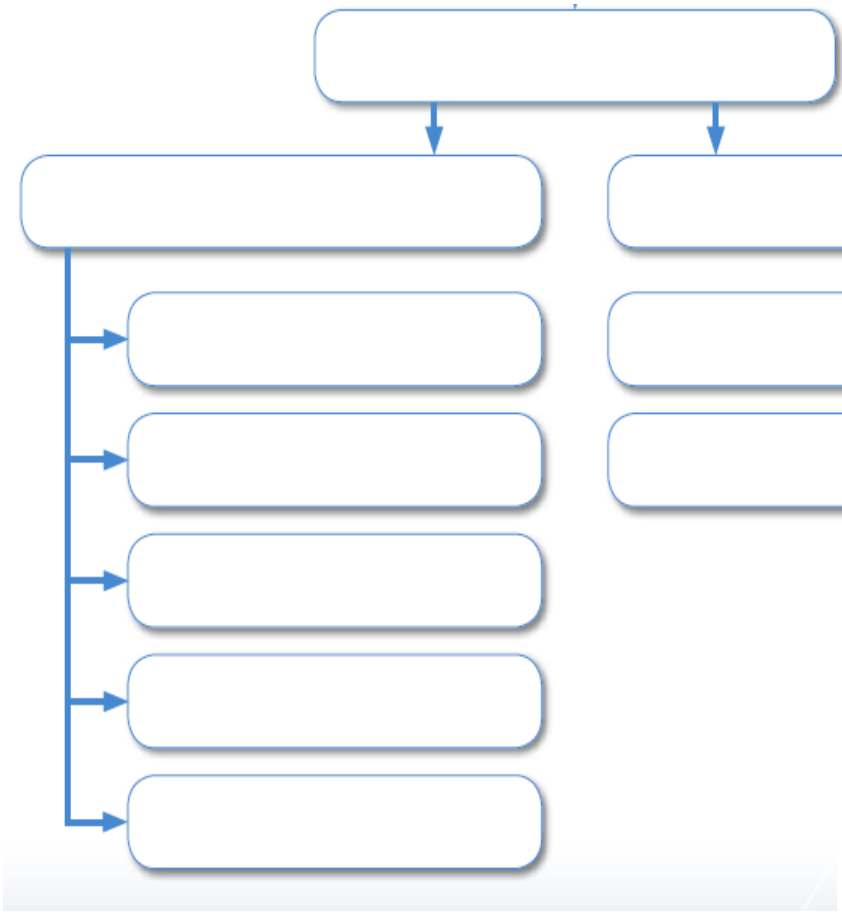
1.2.3. Complete the Venn diagram below to show similarities and differences between bacteria and viruses. Write as many as you know.

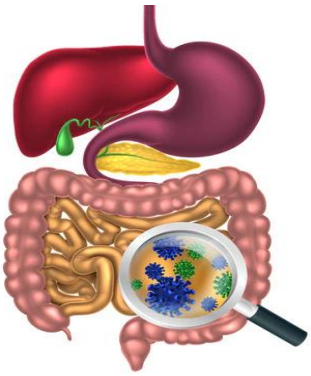
Bacteria **Viruses**



1.2.4. The concept map below relates to useful and harmful microbes. Complete the map, using the following keywords (given in alphabetical order): https://archeia.moec.gov.cy/sm/41/viologia_c_gymn.pdf

Decomposition of dead organisms, Digestion, Diseases, Food products, Harmful microbes, Medicines, Microbes, Pesticides, Spoilage and decomposition of our foods and textiles and houses, Useful microbes.





WHAT DOES SCIENCE TELL US?

Microbes (also known as microorganisms) are everywhere: on surfaces we touch, in the air we breathe, and even inside us. They are too small to be seen without a microscope. Microbes include bacteria, viruses, fungi, and protozoa. They can be both, useful and harmful to humans.

One of the main ways in which bacteria are beneficial is in the food industry. The natural by-products created during normal microbial growth can be used to make many of the food products we eat. Yet, they contribute to digestion, produce vitamin K, promote development of the immune system, and detoxify harmful chemicals. Microbes are also used in pharmaceutical industries for synthesis of chemical drugs, chemical compounds and other compounds. It also leads to discovery of cell mechanisms allows pharmacists to discover antimicrobial drugs that would prevent an escalating number of communicable diseases.

On the other hand, some microbes can be harmful to humans and can cause diseases. However, it is important to know that some microbes are only harmful when taken out of their normal environment.

1.2.5. Conduct research on a Gut microbiome and explain how it influences many human health. Share your research with your Share your research with your classmates by preparing a short presentation, preparing a short presentation.

1.2.6. Watch the video entitled *Spread of pathogens* at https://youtu.be/vO51sFre6fg, and then discuss with your group modes of transmission of harmful microbes (pathogenic) and suggest as many methods as you can to prevent the spread of infectious disease.

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1.2.7. Sexually Transmitted Infections (STIs) are infections which are mainly passed from one person to another (that is transmitted) during sexual contact. There are at least 25 different STIs with a range of different symptoms. These diseases may be spread through vaginal, anal or oral sex. Conduct research on STIs, preparing a short presentation, and answer the following questions:

a) What are the most common symptoms of an STI?

b) How can we reduce the risk of contracting an STI?

Share your research with the class.

WHAT DOES SCIENCE TELL US?

The best way to prevent infections is to block pathogens from entering the body by:

a. Good hygiene:
   - Wash your hands well (Hand hygiene)
   - Cover your mouth and nose with a tissue when you sneeze or cough, then dispose of it (Respiratory hygiene)
   - Don't share dishes, glasses, or eating utensils.
   - Avoid direct contact with napkins, tissues, handkerchiefs, or similar items used by others.

b. Food hygiene (Practice good food-safety techniques to avoid getting sick).
c. Sexually Transmitted Infections (STIs) (Engage in sexual contact only with one partner who is having sex only with you and/ or take precautions (e.g., use a latex or polyurethane condom).
d. Avoiding bug-borne pathogens. Both mosquitos and ticks are carriers of viruses and bacteria. And both have been associated with serious epidemics in the last decade.
e. Using animal-control to prevent infections.
f. Vaccinations.

Activity 2: Defence against Microbes and the role of Vaccines (Lessons 4 & 5)

2.1.1. Human body has various types of physical barriers to prevent invasion by a microbe. Below, there are 6 cards (1-6) with 6 different body's barriers, and 6 cards (7-12) with the mechanisms concerning how each barrier is specialised to fight microbes. Study the provided cards and then try to match them. (https://archeia.moec.gov.cy/sm/41/viologia_c_gymn.pdf)

1.Skin

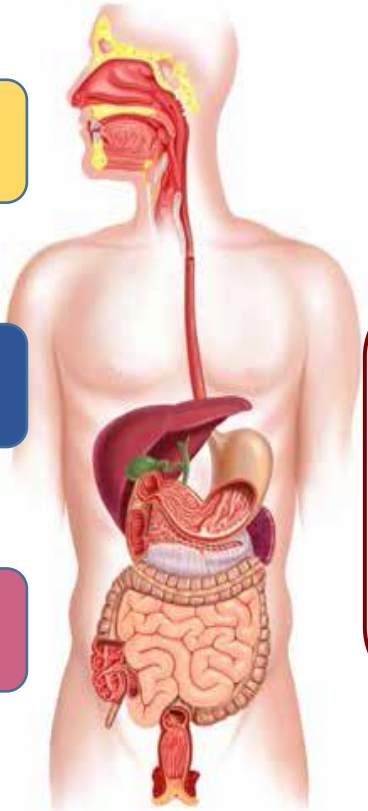
2. Nose

3. Eye

4. Stomach

5. Trachea

6. Mouth



A. The eye has a mechanism of cleaning itself through the movement of substances through blinking. The film of moisture over the eye can trap substances such as dust and through blinking can move it to the corners of the eye where it can be removed. Our tears also contain enzymes such as lysozyme and amylase, which can kill some bacteria providing another level of protection.

B. Cilia are small hairs found along the airways in our nose and trachea. These hairs are located next to mucosal cells which secrete mucus. The mucus can trap particles we inhale, including bacteria and viruses. The movement of the hairs in the nose stimulates sneezing and in the lungs they can move the mucus to the throat where it can be coughed out or swallowed.

C. Saliva contains lysozyme (an enzyme) that destroys microbes in the mouth.
.

E. The acid in our stomach not only aids digestion but can also kill some pathogens. Pathogens that are not killed by this acid (Gastric acid) can potentially cause disease, such as Salmonella which causes food poisoning. 4.

D. Skin provides a physical barrier for our body. Entry through this barrier for pathogens can occur when the skin is broken, irritated or damaged from cuts and wounds. Skin sebum and sweat contain lactic acid that inhibits microbes.

2.1.2. Watch the video*The first line of defence against harmful microbes* and correct your answers. https://www.youtube.com/watch?v=5X9MklLVhlw&list=TLPQMDYxMTIwMjOzpqZ23BF6LA

WHAT DOES SCIENCE TELL US?

Our body fights harmful microbes and other substances every day. Microbes must fight through three levels of our body's defences before they can cause us harm.

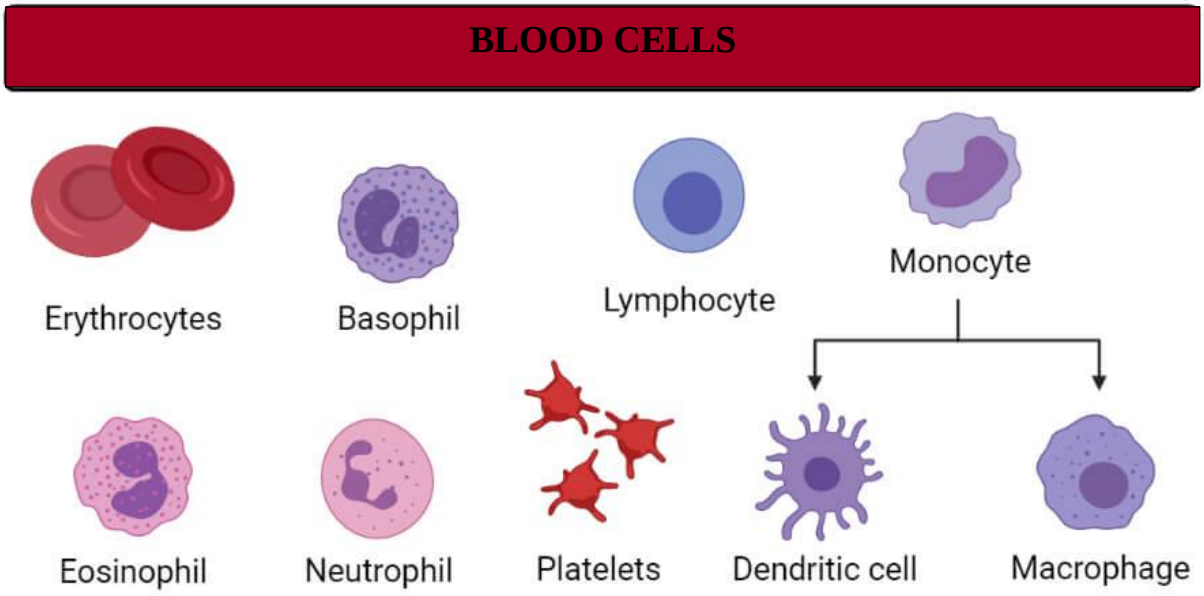
- The first line of defence
- The second line of defence
- The third line of defence

The collection of organs, tissues, cells, and cell that helps to remove harmful microbes or substances from the body is called **Immune system**. A condition of being able to resist a particular disease especially through preventing development of a pathogenic microorganism or by counteracting the effects of its products is called **Immunity.**

The part, or parts, of any foreign substance that are recognised by the immune system are known as **antigens**. The body's first line of defence against antigens is the variety of physical barriers it possesses in order to prevent entry.

2.2. If a microbe isn't cleared from the body by the physical barriers, what happens next?

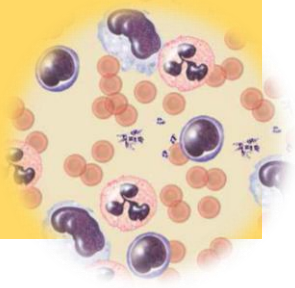
2.2.1. First, observe the pictures below and study the related text to remember the structure and function of blood (Baytelman et al., 2018, in greek).
https://archeia.moec.gov.cy/sm/41/viologia_c_gymn.pdf



Blood contains three different types of blood cells, namely, red blood cell (erythrocytes), white blood cell (leukocytes), and platelets.

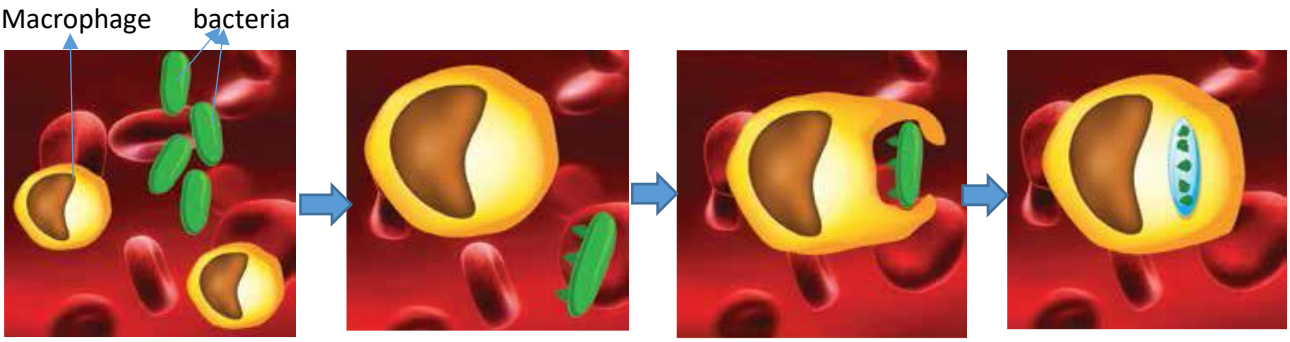
Plasma is the liquid portion of blood. About 55% of our blood is Plasma. Plasma is about 92% water.

White blood cells play an essential role in phagocytosis and immunity. and therefore, in defence against infection.



2.2.2. Watch the video show *the second and third line of defence to remove harmful microbes or substances from the body.* *https://www.youtube.com/watch?v=HSrrPdJDqxM*

Then, observe the four pictures below and the provided text, and explain step by step the second line of defence against harmful microbes or foreign substances (http://www.e-bug.eu/).



If the physical barriers are breached, for example by bacteria entering the body through the skin, The White Blood Cells called '**macrophages**' notice anything foreign or strange that gets through the first line of defence and move towards that 'foreign object'. The word macrophage means 'big eater'. The macrophages then surround and destroy the foreign object or, in this case, microbe. This process is called **phagocytosis**.

This process is rapid, and non-specific. This means, it is the same for all foreign objects or microbes and is called **Innate Immunity**.

Picture 1: ……...

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Picture 2: ……...

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Picture 3: ……...

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Picture 4: ……...

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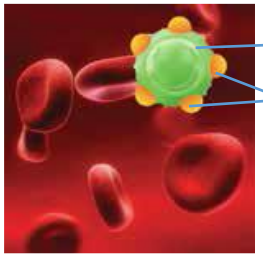
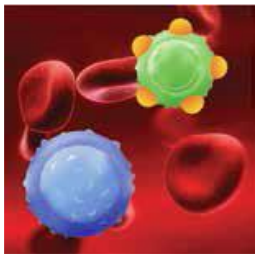
If a microbe isn't cleared from the body by the innate immune response (when the body's phagocytes respond to eliminate the pathogen), what happens next?

The third line of defence is to remove harmful microbes or substances from the body. Observe the pictures below and study the related text. Discuss with your group your observations and write a caption next to each picture.



1. _____

_____



2. _____

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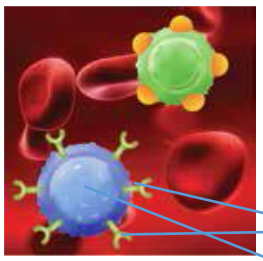
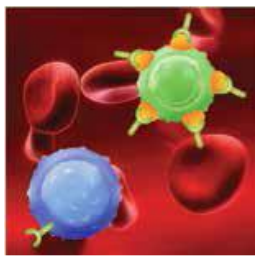


3. _____

_____



4. _____

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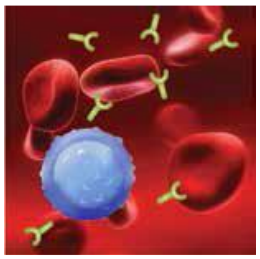
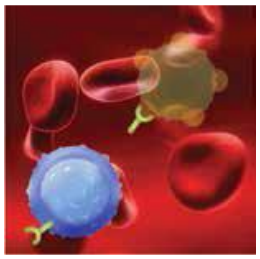


5. _____

_____



6. _____

_____

http://www.e-bug.eu/

The innate immune response may not always clear an infection. If this happens, the **acquired/ adaptive immunity** is activated.

The macrophages that have taken up the antigen can also transport the antigen to sites where an acquired immune response can be activated.

All invading cells have distinctive antigens on their surface

When the **specific white blood cell** (lymphocyte) comes across a microbe, it will:
(a) make an **antibody** (protein molecules) to match that microbe's antigen,

(b) tell all the other specific white blood cells to make lots of that antibody

The body's antibodies find their matching antigen on the harmful microbes and lock on to them

The antibodies will then:

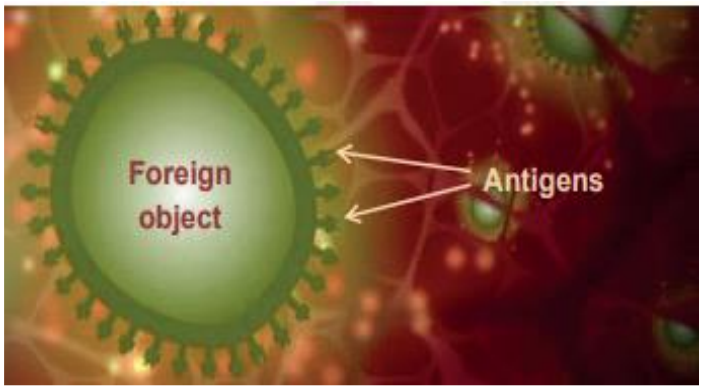
(a) Mark the harmful microbes for destruction.

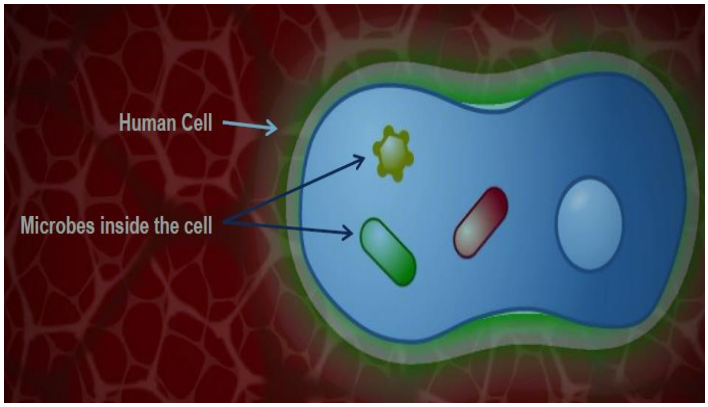
(b) Stay in the blood after the harmful microbes have been killed ready to fight them if they should ever return (immune memory).

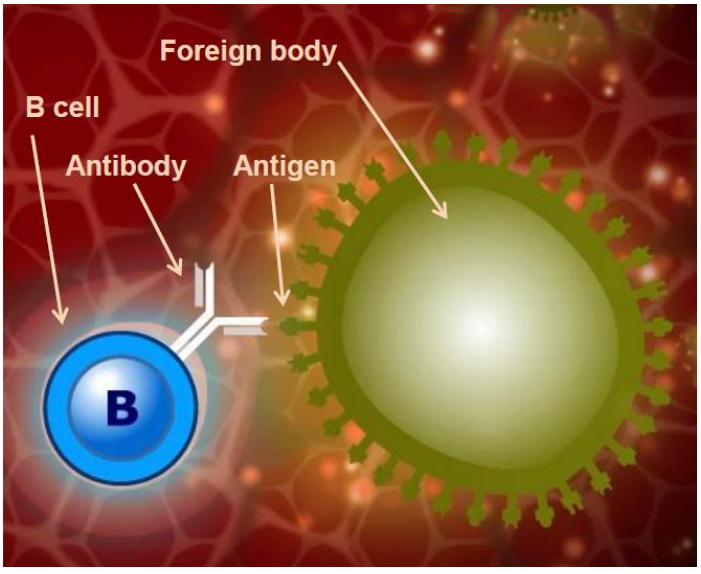
2.2.3. Observe the pictures below and use the words in the list below (given in alphabetical order) to complete the sentences concerning innate and acquired/ adaptive immunity:

Antibody, Antigens, Bacteria, Cilia, Innate immune system, Macrophages, phagocytosis, Physical barriers, Skin, Tears.

http://www.e-bug.eu/







The function of the immune system is to distinguish foreign substances from substances that are part of our own bodies. The part, or parts, of any foreign substance that are recognised by the immune system are known as _____.

The body's first line of defence against foreign substances is the variety of _____.

This includes _____, gastric acid, _____, tiny hairs called _____, and lysozyme.

If these _____ are breached, for example by _____ entering the body through the skin, the _____ encounter large cells called _____ which are resident in the skin

If a _____ recognises the antigen as something foreign and not 'self' it engulfs it by a process called _____and can destroy it (second line of defence).

Sometimes, this innate response alone is not sufficient to eliminate the _____.

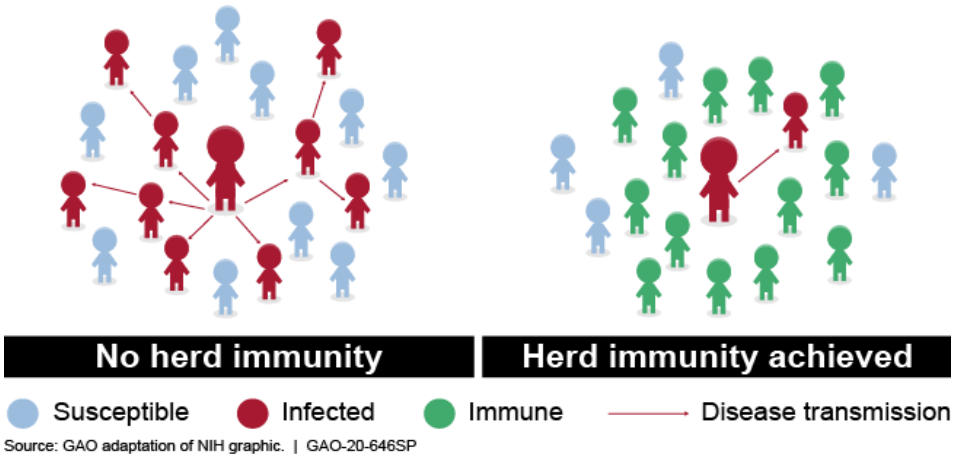
The_____ stimulates the acquired immune system. Specific white blood cells produce a specific _____ by interacting with the antigen. _____ is a complementary match to the antigen and stimulates killing of the foreign substance (Third line of defence).

2.3. In the next lesson, we will explore the socio-scientific issue entitled *Should a low efficacy vaccine be released to the public?*

What is the relation between immunity and vaccines? How do vaccines work against pathogens? Do you know some important vaccines in human history? Is natural immunity better than acquired immunity? Do you know what herd immunity is?
Knowledge of how vaccines work with the immune system and why vaccines are important to people now and throughout their life allows us to understand the vaccine importance and schedule more clearly.

2.3.1. To answer the driving question of the socio-scientific issue concerning vaccines, we need to understand some basic aspects about vaccines and vaccination. Watch the video entitled *the history of vaccines* at https://youtu.be/WZ7g1nGjGbQ, and then discuss with your group the above questions. Then, match the terms of column 1 and the sentences of column 2.

No	COLUMN 1	COLUMN 2	No
1.	Herd immunity	They protect us from illness and others from getting ill too.	**A**
2.	Infectious diseases	Vaccines can train our body to prevent sicknesses before they even start. They do this by introducing a substance called antigen that can stimulate an immune response.	**B**
3.	Vaccinations	Component of blood that helps defend the body against infection. .	**C**
4.	Vaccine	High levels of vaccine coverage must be maintained in the population to achieve and preserve it and to protect those who cannot be immunised.	**D**
5.	White blood cells	Vaccination has successfully reduced the prevalence of fatal diseases (e.g., polio, measles, and now, COVID-19 amongst many others).	**E**



2.3.2. Construct a concept map using the following concepts, and draw the necessary connections between concepts, using arrows with correct direction and appropriate and specific verbs or propositions.

Immunity, human, antigen, antibodies, immune system, infectious disease, vaccines, attenuated bacteria, dead (inactivated) virus, toxins.

CONCEPT MAP

2.3.3. Some people argue that natural immunity is better than acquired immunity. What is your position?

Discuss with your group this statement, and then write your position, explaining your reasoning.

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2.3.4. In some cases, infectious diseases can spread in communities or large areas, this is called an epidemic. When the disease spreads to over an entire country or around the world this is known as a pandemic.

The COVID-19 pandemic started when a new virus SARS-CoV-2 caused the disease COVID-19, infecting a population in China. Because this virus was very infectious, and global travel is so commonplace, it was able to spread quickly and infect people all over the world.

Compare the spread of Spanish flu (1918) with the Covid 19 (2019) and write your conclusions concerning the role of vaccines in tackling pandemics.

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Activity 3: Research Project: How science responds to vaccines hesitancy (Lessons 6-9)

3.1. To explore the socio-scientific issue concerning vaccines and vaccinations, first it is very useful to prepare a work plan, which will guide you to answer the primary research questions. It is useful to use the jigsaw technique.

No	Components of research plan	Explanations for components of research plan
1.	**Theoretical Background**	The background section is straightforward. It consists of a few sentences on what the research is about and why it is happening. The background also includes a problem statement.
2.	**Objectives and Primary research questions**	In this part you will explain the specific aims of your research and what you specifically want to find out through this research process based on your research questions, you're trying to answer.
3.	**Participants**	You must define the type and number of participants you will rely on to get the insights and data you need.
4.	**Methodology**	In this section, talk briefly about the chosen data collection instruments and the reasons behind why that particular method was chosen (e.g., Interviews, Questionnaire, scientific texts, articles, pictures, videos, tables, diagrams, simulations and scientific measurements), as well as the method of data analysis.
5.	**Results and Conclusions**	In this section, write the results of your investigation and your conclusions concerning your primary research questions.
6.	**Approximate Timeline**	It is useful to place an approximate timeline in your research plan. (e.g., Research start date, Data Collection, Analysis, Conclusions, Date of Presentation-Open schooling event).
7	**Form of actions**	e.g., Organising a public event for discussion, reflection, presentation of research, exhibition of scientific poster. Promote a public debate, distribute an information brochure, etc.

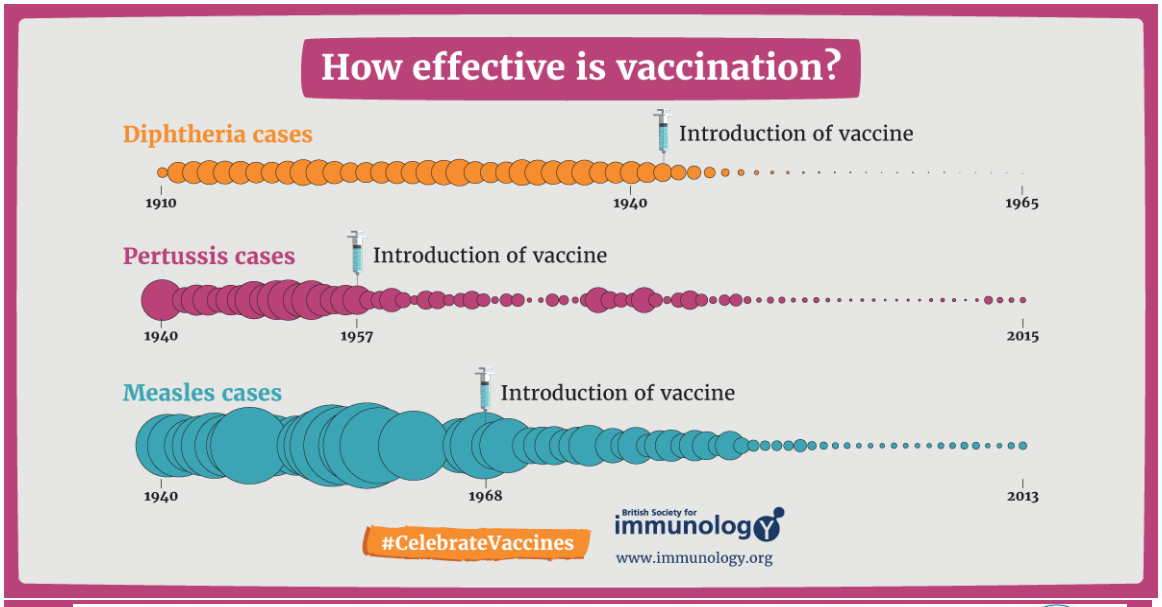
Evaluate information and consider the source and author of the information used, the purpose of the publication, potential biases of the author or publisher, evidentiary support for the information, and possible missing information.

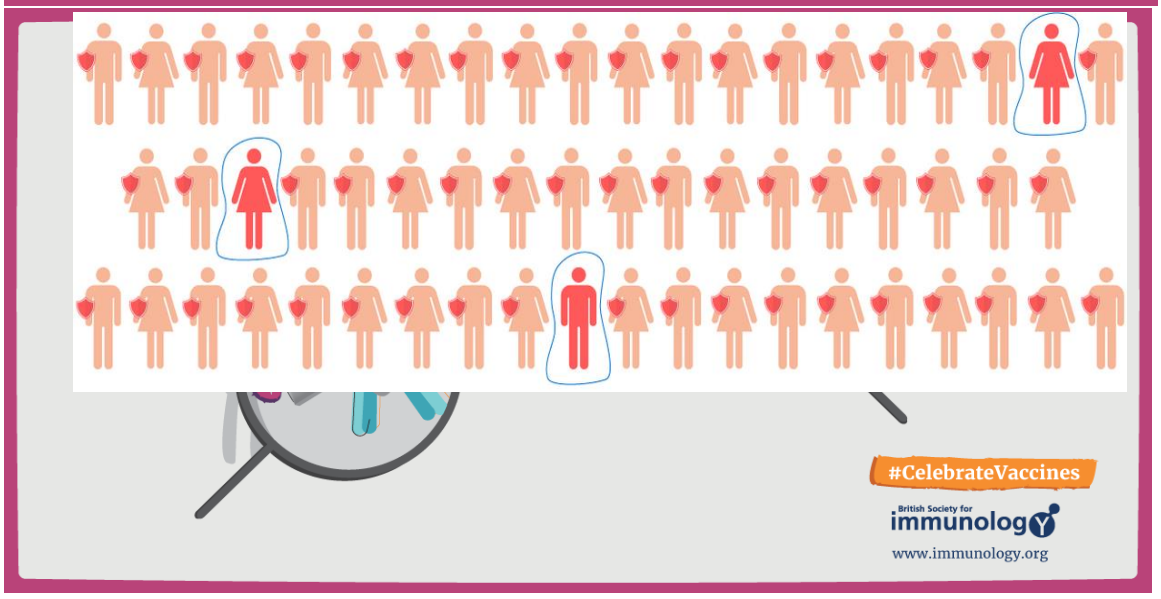
3.2. How do vaccines influence the progress of an epidemic and a pandemic?

To answer the question concerning vaccines' impact on the progress of an epidemic and a pandemic, you should first read the text WHAT SCIENCE TELL US and the diagrams about vaccines and vaccinations.

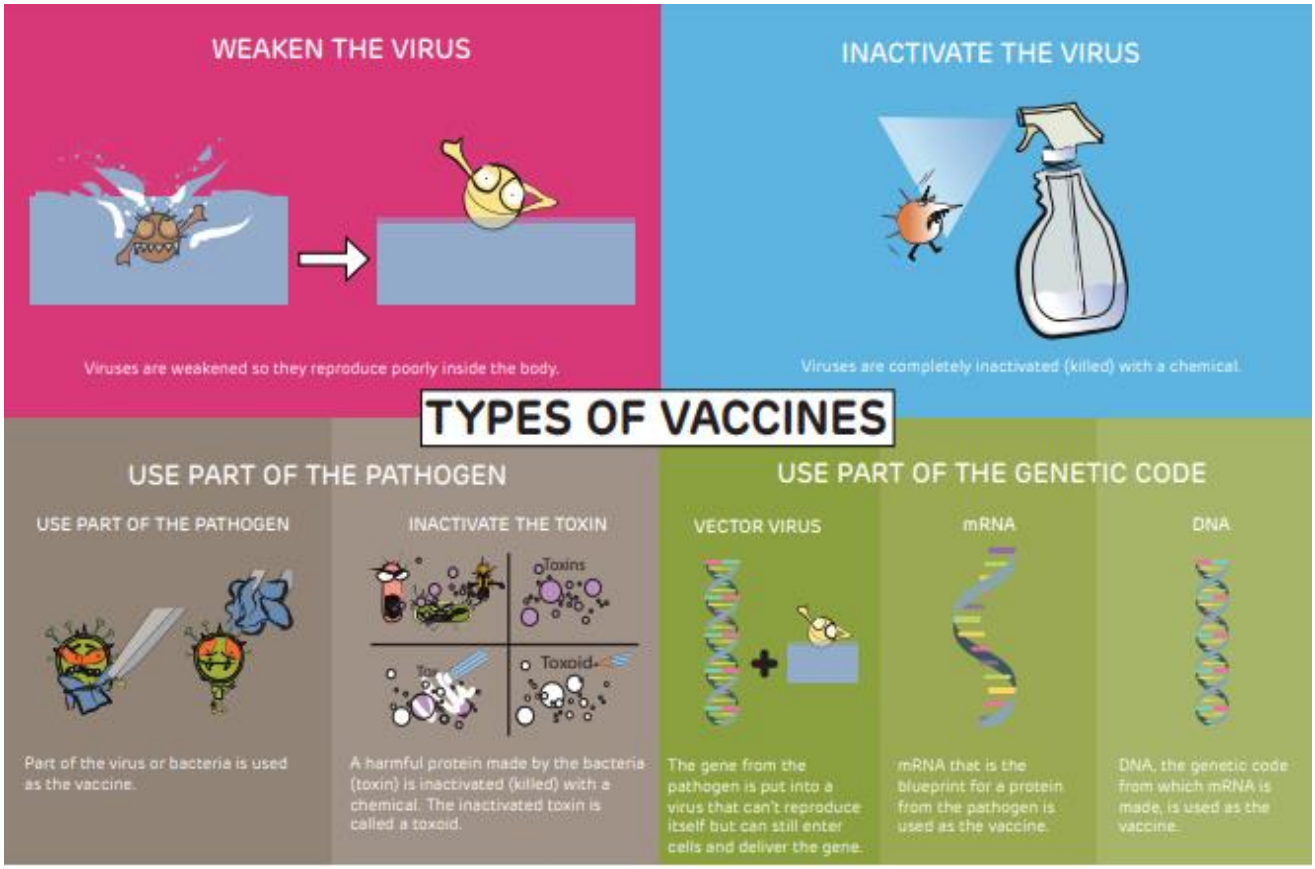
WHAT SCIENCE TELL US

When a person becomes infected with a virus, the immune system responds to attack the virus, so the infected person doesn't get too sick. After the virus is eliminated, the person's immune system creates cells that will remember the virus (called memory cells) so that if the person ever gets infected by the same virus again the immune system can respond very quickly, and the person probably won't even notice he/she is infected. Many years ago, scientists developed vaccines, which causes the immune response and the creation of memory cells.





Herd immunity: Vaccines indirectly protect others who are vulnerable to disease. These include babies, children, the elderly, people with weak immune systems, cancer patients, and people who cannot be vaccinated for others medical reasons.



Vaccination: Inoculation with a vaccine in order to protect against a particular infection**.**

https://www.youtube.com/watch?v=uPeZBhJYlnU

3.2.1. From the above information, what are the benefits of vaccination for (a) individuals, (b) the community?

(a)……

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(b)……

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3.2.2. Formulate some specific questions and hypotheses which should help you to answer the first main question of your investigation: *How do vaccines influence the progress of an epidemic and a pandemic?*

Question1: ……

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Question 2: ……

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Question 3: ……..……

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Question 4: ……

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Hypothesis 1: ……...

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Hypothesis 2……...

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Hypothesis 3……

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Hypothesis 4……

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3.2.3. Name some sources where you can find more information to answer your questions. Think also about history of epidemics and pandemics!

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3.2.4. Discuss with your group about the information and the sources you should use to answer the question concerning vaccines' impact on the progress of an epidemic and a pandemic. After searching and evaluating related information, you must analyse your data, make inferences, synthesize and draw conclusions. Discuss briefly with your group your final conclusions and then write below your main conclusions.

How do vaccines influence the progress of an epidemic and a pandemic?

3.3. What are the local community's perceptions and knowledge concerning immunity and vaccinations?

3.3.1. To answer this question, you should prepare a short questionnaire and/or interviews to investigate the perceptions and knowledge of the people in your community about immunity and vaccinations. Later, you will present the results of this investigation at the public event (open schooling event). During the public event, you will discuss and debate the perceptions and knowledge about immunity and vaccinations expressed by the local community participants, as well as challenges raised, and suggest ways to address them.

3.3.2. For this purpose, you should distribute your questionnaire to your parents, relatives, and other residents of the area where you live to complete it. In addition, you can conduct some interviews.

3.3.3. After data collection, you need to analyse the data and write your results and draw conclusions.

3.3.4. Prepare a scientific presentation on the topic *Vaccines development and the science that responds to hesitancy*.

3.4. Should a low efficacy vaccine be released to the public? (Debate)

3.4.1. To debate the socio-scientific issue concerning low efficacy vaccine, first it is very useful to carefully read the socio-scientific dilemma and then prepare a work plan, which will guide you to develop an informed decision regarding the dilemma: *Should a low efficacy vaccine be released to the public?* and then organize and conduct a public debate.

Recently, a new virus has spread around the world, which has caused a lot of businesses to shut down and schools to close to limit the spread. Many pharmaceutical companies try to develop a vaccine that passes rigorous approval tests. One vaccine candidate has passed all these tests, but it has a low efficacy rate of around 50%, meaning that a person who is vaccinated is only half as likely to get sick from the real virus, then a person who is not vaccinated.

The pharmaceutical company argues that the vaccine should be distributed anyway, so that people can be protected, and life can get back to normality. The government people also agree because they want the economy to improve. On the other hand, public health workers are concerned that if a vaccine that has such low efficacy is distributed, people may relax their other preventative behaviours such as avoiding large social gatherings or wearing masks. They are, particularly, worried because a lot of people have signalled that they are afraid to get vaccinated at all.

Discuss with your group about the steps you should follow to develop an informed decision regarding the driving qustion of the above sociosientific issue *Should a low efficacy vaccine be released to the public?* Use the information below to prepare your work plan.

No	Steps of work plan
1.	Read, recognise, and understand a socioscientific dilemma entitled: *Should a low efficacy vaccine be released to the public?*
2.	Search information from a variety of sources (scientific texts, articles, pictures, videos, tables, diagrams, simulations and scientific measurements, interviews, etc.).
3.	Evaluate information and consider the source and author of the information used, the purpose of the publication, potential biases of the author or publisher, evidentiary support for the information, and possible missing information.
4.	Construct different types of valid arguments.
5.	Become aware of the arguments and values that others might use and try to construct counterarguments.
6.	Think through the consequences of your decision.
7.	Be aware of the necessary steps to arrive at a well-grounded decision.
8.	Plan, organize, and conduct a public debate.

3.4.2. Construction of Arguments

Construct different types of arguments, social, ethical, economic, and scientific, expressing your opinion for a dilemma *Should a low efficacy vaccine be released to the public?* Support your claims, using as many as possible justifications supported by evidence. (Baytelman, 2015).

3.4.2.1. Underline the answer that best represents your position:

(a) Yes, (b) No

Arguments (You can write different types of arguments according to your position.)

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3.4.2.2. Construction of Counterarguments

If somebody holds the opposite position to yours on this dilemma, what arguments may he/she have? Support your claims, using as many as possible justifications supported by evidence.

Counterarguments (You can write different types of arguments according to your position.)

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3.4.2.3. Construction of Counter-Counterarguments

Referring to your counterarguments you have given above, can you write down your opposite ideas to justify your position?

Counter-Counterarguments (rebuttals) (You can write different types of arguments according to your position)

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3.4.3. Organizing and conducting a public debate on the topic: Should a low efficacy vaccine be released to the public?

3.4.3.1. How do we plan, organize, and conduct a public debate? Discuss with your group on the following for the debate preparation:

i. Explain the dilemma for a debate.
ii. Organize the teams for a debate.
iii. Establish the rules of the debate, including timelines.
iv. Gather supporting evidence and examples for position taken.
v. Research the topic and prepare valid arguments for your decision.
vi. Anticipate counter arguments and prepare rebuttals.
vii. Team members plan order and content of speaking in debate.
viii. Prepare place for debate.
ix. Create a rubric for evaluation of debate.
x. Others.

3.4.3.2. Steps of argumentation: Group 1 Vs Group 2

Step 1: The first speaker of group 1 presents the group's argument and defines the key words

Step 2: Key position of the speaker of group 2- Counterargument on the argument of the first group

Step 3: Second argument of group 1

Step 4: Second counterargument of group 2

Step 5: Concluding remark of group 1

Step 6: Concluding remark of group 2

Activity 4: Public Event (Open Schooling Event)

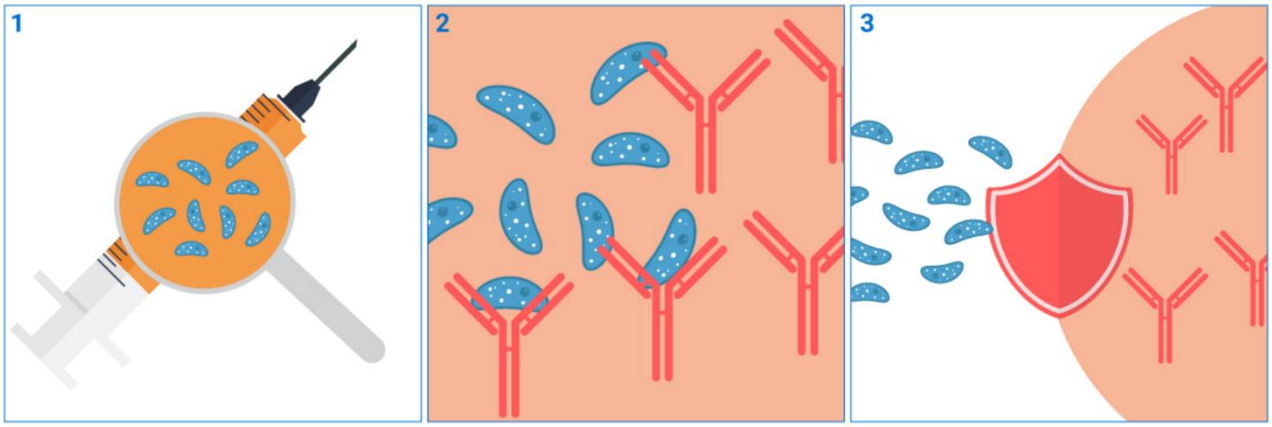
4.1. The final activity of this module is the organisation of a public event entitled: *Vaccines development and how science responds to hesitancy*. For this event it would be useful to create an informative flyer (brochure) concerning the role of vaccinations for public health, and distribute it to the participants of the public event.

Designing, organizing, and holding a public event (students, teachers, parents, social partners of the local community) is an opportunity for you to present your research project, answering your research questions and debate with the public. You are research questions are:

1. How do vaccines influence the progress of an epidemic and a pandemic?
2. What are the local community's perceptions and knowledge concerning immunity and vaccination?
3. Should a low efficacy vaccine be released to the public? (Debate)

4.2. To create an informative flyer concerning *Vaccine and Vaccinations* for *the promotion of public health*, you should take in consideration the following:

- Must be appealing and interesting.
- Must include scientific information from valid and accurate resources.
- Must be understandable and accessible to all ages and people from all socio-economic groups and educational level.



4.3. Write down the agenda for the public debate (students, teachers, parents, social partners of the local community) on the topic: *Vaccines development and how science responds to hesitancy.*

Agenda

4.4. Prepare and write down the agenda for the public event (students, teachers, parents, social partners of the local community) on the topic: *Vaccines development and how science responds to hesitancy.*

Invitation

Holding a public debate (students, teachers, parents, social partners of the local community) on the topic: *Vaccines development and how science responds to hesitancy.*

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