**Project Number:** 101006468

**Project Acronym:** PAFSE

**Project title:** Partnerships for Science Education

**SECOND VERSION OF EDUCATIONAL SCENARIO**

Planet of viruses

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| --- | --- |
| The European Union | OSCE | This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 101006468 |

**Second version of educational scenario**

In this version of educational scenarios a few changes are introduced which answer the conclusions which arise from evaluations of the scenarios with the teacher. Main idea which arises from them after conducting the scenarios that their first version was too robust and hard to navigate. Also, as anticipated some of the activities were more successful than others. Because of that the activities which should be a priority or recommended by the teachersare highlighted.

Moreover, and necessary theory and introduction is only in the first version of the educational scenario. The idea of the second version scenario is to be “ready to go” for the teacher – which is possible to take quick look on activities, print necessary materials and conduct the lesson.

In each scenario, varieties of activities are proposed, we recommend putting special focus on elements of Inquiry Based Science Education – especially argumentation and project-based learning.

Argumentation is a skill useful for students and teachers. Thanks to it students construct complex answers to the problem which take exceptions into account. That way students are aware of comprehensiveness of the science world, in which one answer is right according to the current knowledge, but it also requires certain circumstances and conditions to be true. This kind of answering is also partially used in national biology exam which makes it even more worthy and applicable to train.

Moreover, projects proposed in the scenarios are perfect opportunity for students to challenge their skill of true scientist. Project based learning gives students great opportunities to be independent in the classroom and learn from their own mistakes. It also gives them more satisfaction from the task which is completed with small or no help of the teacher. All proposed projects in the scenarios are low cost, easy to conduct in the classroom or at home, making them accessible for all of the students despite possible financial constraints.

Recommended activities are highlighted by symbolObraz zawierający rafa, Majorelle blue, Wielobarwność, sztuka

Opis wygenerowany automatycznie

**Lesson 1-2 - What is the virus?**

Objectives

In terms of knowledge:

Student:

* defines what life is,
* lists the features of living matter,
* gives the features of viruses that indicate belonging to the living world,
* gives the features of viruses that indicate belonging to the inanimate world.

In terms of skills

Student:

* argues that viruses belong to the living world,
* argues that viruses belong to the inanimate world,
* plans the sequence of arguments used during the debate,
* designs the course of the debate on the belonging of viruses to the animate or inanimate world.

In terms of attitudes

Student:

* recognizes the complexity and variety of infectious agents that are viruses.

Methods

* Elements of the reversed class
* Visual methods - film
* Content analysis
* Group work - negotiating meanings
* Discussion
* Oxford debate

RECOMENDED: ACTIVITY 4

The course of the lesson:

The main dilemma - are viruses alive or not?

**Activity 1**

The lesson begins with the presentation of fragments of films about what life is (it is recommended to watch only fragments of the film in the class - and the whole film before class)

An introductory film about the life

- extended version (after an hour or more) in English

<https://www.youtube.com/watch?v=_z-SUo2wP4I>

- what is life?

<https://youtu.be/QOCaacO8wus> - what is life?

Analysis of the content of articles:

An attempt to write a definition of life - based on personal knowledge and watching the movie. Then analyze an article from the blog "It's just a theory" or other sources of information.

Students compare their definitions with the definitions they receive from scientific sources - they create one synthetic definition of life.

- Problem "n = 1" - how do we know what life should look like since we know only one kind of life - a life that exists on Earth. All living things are likely descended from a single LUCA ancestor. Could life from a different source be completely different?

A problem to consider in the discussion - why define life? Many scholars and philosophers consider this problem artificial, and it is unnecessary to deal with it. Yet a definition of life is needed in areas such as astrobiology (the search for extraterrestrial life), synthetic biology (an attempt to create artificial living organisms), and evolutionary biology (an attempt to understand the origin and origins of life).

4) definition of life

<https://plato.stanford.edu/entries/life/>

5) article – its only theory – in Polish

<https://www.totylkoteoria.pl/czym-jest-zycie/>

6) Khan Academy article

<https://www.khanacademy.org/science/biology/intro-to-biology/what-is-biology/a/what-is-life>

Other sources:

<https://www.biologyonline.com/dictionary/life>

<https://www.degruyter.com/document/doi/10.1515/bmc-2020-0001/html>

Tsokolov, S. A. (2009). Why is the definition of life so elusive? Epistemological considerations. *Astrobiology*, *9*(4), 401-412. <https://www.liebertpub.com/doi/pdfplus/10.1089/ast.2007.0201?casa_token=VlG-uK1fOcsAAAAA:nnUffKjr8y0Jajx8yWGrqmgBl4mRXks7AjHUi_L5-9MJVze30x9zhMysPis9i-CuPPS8CQhwSUHBriq6>

**Activity 2**

Negotiating the meaning of the term "life" together

Concerning the created definitions of life, it is worth considering what features animate and inanimate matter has. Then it is worth testing the truth and usefulness of the proposed definitions based on examples of the so-called borderline cases in class discussions.

Examples of borderline cases:

- sterile organisms (e.g., silt)

- intracellular parasites - rickettsiae, chlamydia

- anabiosis (a state of extreme decline in the vital activity of the body, usually in response to adverse environmental conditions)

- abiogenesis (a natural life process taking place in non-living matter, e.g., inorganic compounds);

- simplified endosymbionts - mitochondria and plastids

- artificial life / artificial intelligence / empathic robots

- xenobots

- viruses

- computer viruses

One of the welcome conclusions from the discussion should be the message that it is not always easy to distinguish between the animate and the inanimate from a biological point of view. We must have several criteria.

**Activity 3**

Compare the definitions given by the students with those given by the scholars:

"Life is a self-sustaining chemical system capable of undergoing Darwinian evolution" [Joyce 1994] - Questions that could be asked when presenting this definition: How do you know what meets your requirements and what does not? What does "self-supporting" mean? Can parasites or adulterous organisms live "by themselves"? Or maybe life is a system of all organisms that cannot be separated. What does "evolve" actually mean?

"A living organism is an autopoietic system" - they can reproduce themselves (copies of themselves) and their parts. Questions that can be asked when presenting this definition: But what about the evolution and variability of organisms? Are the robots producing robots alive? Are there "superorganisms" such as swarms, societies, etc.

"We define life as a set of self-sustaining (autopoietic) objects capable of evolution by natural selection" "a living individual is a network of negative feedback (regulatory mechanisms) serving the superior positive feedback (potential for expansion)" - Questions that can be asked while presenting this definition: Is life a learning process?

At this point, it is also worth referring to three life systems and three basic levels of the organization of living matter:

Living organisms are, without exception, composed of three interrelated subsystems:

* metabolic system - ensuring energy autonomy
* information system - providing regulation and control
* compartmentalization system - ensuring separation from the outside world.

The three basic levels of the organization of living matter include:

\* Cell level:

-metabolic system: autocatalytic biochemical processes of the cell

-information system: DNA and gene expression mechanism

-compartmentalization system: cell membrane, cell wall, cytoskeleton

\* Body level:

-metabolic system: digestive system, respiratory system, circulatory system

-information system: the nervous system and the endocrine system

-compartmentalization system: skin, immune system, musculoskeletal system

\* Superorganism level:

-metabolic system: food exchange systems, group hunting

-information system: interpersonal signal systems, social hierarchy, pheromone systems

-compartmentalization system: territories and borders.

**A**Obraz zawierający rafa, Majorelle blue, Wielobarwność, sztuka

Opis wygenerowany automatycznie**ctivity 4**

Distinguishing features of living and inanimate matter.

We begin our discussion with students with the question: What are the manifestations of life in general - and why is one indication not sufficient to consider a creature alive?

What does it mean to live? What features do all living organisms have in common?

- multiplication (difference with multiplication?),

- evolution (?),

- metabolism - Erwin Schrödinger "Metabolism is the ability to lower the level of its entropy (disorder) at the expense of the entropy of the environment (Schrödinger 1998)."

- homeostasis (maintaining the right conditions inside the cell to function),

- reacting to stimuli,

- construction organization (cellular, tissue);

**Activity 5.**

Presentation of the structure and nature of viruses

Screening of a video introducing the issue of Viruses [(Updated)](https://www.youtube.com/watch?v=8FqlTslU22s&t=1s)

<https://pl.wikipedia.org/wiki/Wirusy#/media/Plik:Virion.png>

The basic structure of the virus

A. Non-enveloped viruses. B. Enveloped viruses

1. Kapsyd

2. Nucleic acid

3. Capsomer

4. Nucleocapsid

5. Virion

6. Lipid sheath

7. Insets

- they are made of only DNA or RNA and proteins that surround them (some also have a lipid envelope),

- they do not move,

- obligatory intracellular parasites - they cannot produce energy by themselves and do not have their metabolism, and their replication (duplication) takes place only inside the living cells of another organism,

+ take control of a cell, creating something like a new organism, the sole purpose of which is to reproduce the virus and thus "reproduce" (in this case, more often referred to as multiplication)

+ infected cells can receive and respond to signals necessary for viral replication. Some viruses can even "communicate" by passing a signal from one infected cell to another. This is how viruses regulate their multiplication strategy,

+ viruses evolve like other life forms. They are subject to natural selection, recombination mutations, etc.

Question - can you see viruses?

[Harvard sees viruses in a new light](https://www.youtube.com/watch?v=lIE98Z0SHR0&t=65s)

**Activity 6.**

The Oxford debate - do viruses belong to the animate and inanimate world.

Preparation of arguments for and against when analyzing the received materials.

Conducting the Oxford debate.

RULES OF THE OXFORD DEBATE

ARGUMENT STRUCTURE

What are viruses, according to virologists?

2) <https://www.youtube.com/watch?v=Tryg5UCp6fI>

Are viruses alive? Carl Zimmer

3) What is a virus <https://www.youtube.com/watch?v=jX3MhWWi6n4>

• Summary – what do you think about it, Nobel award winners? ("Viruses are Viruses") André Lwoff. The concept of virus. J. Gen. Microbiol. 17: 239-253 1957

"You could almost say that viruses cycle between being alive, when chemically active and reproducing in host cells, and not being alive when existing as chemically inert viruses outside a cell." Paul Nurse. What Is Life? New York: W. W. Norton and Company, Inc. 2021

**Lesson 3-4 Viruses - their simple structure and complex relationships.**

Objectives

In terms of news:

Student:

* lists the structural elements of viruses (glycoproteins, capsomers, capsid, virion, tail, virion, genetic material - RNA or DNA, sheath),
* classifies viruses in terms of virion symmetry,
* gives examples of different viruses,
* determines the size of viruses,
* defines the terms: parasitism, parasitoid, and predation.

In terms of skills

Student:

* constructs a mind map of the places where viruses occur,
* designs a virus model,
* analyzes the importance of washing hands with soap in the context of the structure of the virus and its lipid coat,
* shows a relationship between the structure of the virus and its way of entering the cell,
* analyzes the lytic and lysogenic cycle of viruses,
* compares the lytic and lysogenic cycles of the virus, pointing to their importance for virus survival.

In terms of attitudes

* recognizes the complexity and variety of virus forms.

Methods

* Visual methods - film
* Content analysis
* Group work - negotiating meanings
* Discussion
* Brainstorming - and its record in the form of a mind map according to the method: think-pair-share (think and draw - share your map with a neighbor and verify the map - discuss on the forum)
* Building a virus model

RECOMENDED ACTIVITIES: 4,8

The course of the lesson:

**Activity 1**

Students draw the virus and the infectious cycle to the best of their knowledge and without additional support material. Through this activity, we stimulate students to present and visualize their current ideas about viruses, which can be rebuilt during subsequent activities during the lesson.

**Activity 2**

Brainstorming - Where can we find viruses? And where do we usually meet them?

Where are most of them? Are there virus-free places on Earth?

Command: Application of the idea: think - pair - share

Construct a mind map that will answer the above questions.

Discuss your map with your neighbor. Verify your maps.

Present the effects of your work on the forum.

Key idea: Viruses exist EVERYWHERE; there are living organisms that can infect. They are the most numerous biological creations in the world. Their number is vast, and it is estimated that there are 1031 of them on Earth, which is over a trillion times more than people. We observe them in the sea, air, soil, and the bodies of all living things. There are many more in our body than our cells (but they are much smaller than them, so they account for a small part of our mass). Fortunately, most of these viruses aren't just infecting us by microorganisms in our gut, on our skin, etc. Viral DNA.

We know that viruses are the most numerous formations in the Earth's biosphere and that a significant number of them are found in the oceans - they are mainly phages. Each group of organisms has "its" viruses. So in that sense, they are everywhere. Of course, the discussion may be towards man and viral diseases, but it is good to know that viruses have coexisted / co-evolved with all organisms since the dawn of life on Earth.

Where shouldn't they be? In places that should be sterile - e.g., inside our organs. But not always; for example, in 2009, Dana Willner examined what viruses can be inside our bodies. Until her research, the lungs were considered more or less "sterile." The researcher verified this hypothesis and described 174 types of viruses found in human lungs, of which only 10% were known to science. This can be explained by the contact of the lungs with the air we breathe. However, there are other organs in our body that, by assumption, do not have such contact and should be sterile, such as the brain.

**Activity 3**

Problem question: What do the different types of viruses look like?

Key information: Presentation of the diversity of virus structure,

- examples of various viruses,

- genetic material - DNA or RNA,

- capsid - the protein coat that protects the viral genome, often contains proteins that interact with the surface of the host cell (with sites called viral receptors), allowing them to attach to it and then get inside (molecular "pick")

- some viruses have a lipid envelope, which is usually a fragment of the host's membrane along with the viral proteins

Obraz zawierający sztuka, krąg, design

Opis wygenerowany automatycznie 

The virions of some of the most common human viruses and their relative size. Nucleic acids are not to scale. <https://en.wikipedia.org/wiki/Virus>

Obraz zawierający czarne i białe

Opis wygenerowany automatycznie  
Task:

Design a virus model

This activity can be done in collaboration with your math teacher.

The command is: Based on the analysis of the drawing showing the structure of the virus, construct your virus - assembling the virus model (with DNA, capsid, glycoproteins, spikes, etc.). (the difficulty is creating a composite grid to show the structure of viruses)

Supporting materials

- Variety of virus structure

material: <https://viralzone.expasy.org/> (construction)

material: <https://www.rcsb.org/search?q=struct_keywords.pdbx_keywords:VIRUS> (3d models)

Obraz zawierający rafa, Majorelle blue, Wielobarwność, sztuka

Opis wygenerowany automatycznie**Activity 4**

Problem question: Why is it worth washing your hands with soap and water?

The task is to build a virus model and check what happens to its envelope when exposed to soap.

Required materials:

aluminum foil

double-sided tape that stays sticky when wet

butter

butter knife

a small plate

topping for the cake (waxy, elongated)

bowl

hot water

paper towel

soap

spoon

<https://www.sciencebuddies.org/stem-activities/show-soap-kills-virus>

Note: An important aspect of this experiment is to explain what happened and why the viral envelope was damaged.

A more scientific explanation of this phenomenon is available at the link:

<https://www.youtube.com/watch?v=miOPtXTeHYE>

**Activity 5**

Main problem: How big are the viruses?

The task for the student: Order the items below from smallest to largest.

liver

atom

Indian Ocean

ovum

spermatozoid

coliform bacteria

coronavirus

the cell nucleus

Białowieża Primeval Forest

Now compare your answers with the scale of the universe

<https://scaleofuniverse.com/>

Will you improve your list now?

Correct order and size of objects:

Atom 10-10 m

Coronavirus - 9-12 nm (nano = 10-9 m)

Colon bacteria (approx. 2 μm long and approx. 0.8 μm in diameter)

Cell nucleus 3.5 - 20 μm (μm = 10−6 m)

Sperm (human six μm long, the finch itself is 26 μm long)

Ovum (approx. 0.12 mm in diameter, mm = 10−3 m)

Liver - 22-24 cm in the transverse dimension, 15-20 cm in the longitudinal dimension and 12-15 cm in the antero-posterior dimension; cm = 10−2 m

Białowieża Primeval Forest - 3,086 km² - a kilometer is 1000 meters

Indian Ocean - 70,560,000 km²

The size of viruses relative to bacteria or human cells

<https://www.youtube.com/watch?v=slUUu5tO0o4>

**Activity 6**

The main problem: How do viruses enter cells? Demonstrate the relationship between the structure of the virus and how it penetrates the cell.

Analysis of selected educational films and educational materials shows the relationship between the structure of the virus and the way it enters the cell. <https://pl.wikipedia.org/wiki/Wirusy>

The basic scheme of virus entry into cells, duplication of components, assembly and release of viral particles .

**Activity 7**

The main problem: How do viruses survive in cells? Life cycle

Analysis of infographics and content analysis of the life cycle of viruses (additionally, students can be instructed to analyze information from the ZPE - lytic and lysogenic cycle of viruses).

Life cycles of viruses

Viruses can multiply (replicate) in a more or less harmful way to the cell. The easiest way to replicate is through the lytic cycle. In this cycle, the virus enters the cell and quickly takes control of it - it changes its metabolism to produce copies of it. These changes are so dramatic that most of the proteins produced by a cell during an infection are often associated with the virus's multiplication. There is no longer enough energy or nutrients for the cell's normal functioning. As the name suggests, the lytic cycle ends in lysis, i.e., death and cell breakdown. Sometimes a cell bursts under its pressure. The duration of the cycle may vary, but some viruses (e.g., bacteriophages, i.e., bacterial viruses) can complete replication only tens of minutes after penetrating the cell. It is doubtful whether viruses that kill their host so quickly can be called parasites. Some researchers argue that one should rather talk about predators in such a situation.

The lysogenic cycle is different. Viruses that reproduce in this way integrate their genome into the host's DNA after entering the cell. There they stay "dormant," and their genetic material (called a provirus) is copied as a "stowaway" as the cell replicates its DNA. In this way, daughter cells inherit the viral genes as if they were their own. This condition can persist for generations - many genomes have traces of viruses incorporated so long that they have degenerated and lost their ability to reproduce independently. Under certain conditions, a dormant viral genome can be reactivated, i.e., provirus induction. This happens when the cell is under stress (e.g., starvation or radiation). The viral genome is 'cut' from the host DNA, and replication begins, which resembles a lytic cycle.

Many viruses only go through a lytic cycle, and others can enter both the lytic and lysogenic cycles. How they multiply depends on the condition of the host cell. However, there are no viruses that replicate only in the lysogenic cycle (in such a situation, virus particles would never be produced).

Some viruses can persist in an infected cell without producing daughter particles. This condition is called latency, or the latency of the virus in the cell. This is a lysogeny-like condition in bacteriophages. During the latency, the viral genome is present in the cell, but the expression of its genes is minimal. In this state, mainly proteins are produced that maintain the latency. It is also characteristic that the latent infection persists in the cell despite the action of the host's immune system. The latency capability is only characteristic of some viruses, such as the herpes simplex virus (HSV-1). These viruses can remain in the human body for many years without showing clinical symptoms of infection. Under certain conditions, however, the virus can reactivate and produce daughter virions (so-called productive infection). Typically, latent infection only occurs in certain cell types, such as in HSV-1, mainly cells in the central nervous system, and EBV in some immune system cells. The reactivation of a latent virus can occur under the influence of many factors, e.g., decreased immunity, hormones, solar radiation, infection with other pathogens, or other stress.

The student's task is to analyze information and select the elements that allow viruses to survive in cells and guarantee their success on Earth for billions of years.

Suggested information on general strategies for viruses to survive in host cells, which students can write:

* some viruses have a life cycle of 20 minutes, after which the affected cell is no longer alive;
* other viruses act like terrorists - they completely change the metabolism of the cell - they fall as if through a window (receptor) and force the cell to slave labor - in such a way that all cellular resources serve the purpose of the virus - e.g., at the beginning of an attack on a cell there are about 2% of virus RNA, just before cell death, it is already around 98%)
* lysogenic cycle and copying the genetic material of the virus along with the genetic material of bacteria,
* simple structure of viruses,
* virus latency in host cells,
* covering itself with the host's cell membrane, making it difficult for the immune system to detect,
* binding to receptors on the surface of the host cell and penetration of the virion inside.

A movie about the bacteria attack:

<https://www.youtube.com/watch?v=YAy4MxRnPYY&list=PLDtejNiUATM82I70CAGoLVgvjXr09DnQP&index=27>

<https://www.youtube.com/watch?v=V73nEGXUeBY&list=PLDtejNiUATM82I70CAGoLVgvjXr09DnQP&index=26>

How scientists investigate bacteriophages:

<https://www.youtube.com/watch?v=sWM8vRLSRtg&t=133s>

Hershey's and Chase's experiments:

<https://pl.khanacademy.org/science/biology/dna-as-the-genetic-material/dna-discovery-and-structure/a/classic-experiments-dna-as-the-genetic-material>

Additional information sources:

Lityc and lysogenic cycle:

<https://zpe.gov.pl/b/cykle-lityczny-i-lizogeniczny/PjbM0mNOA>

Khan Academy:

<https://pl.khanacademy.org/science/biology/biology-of-viruses/virus-biology/a/bacteriophages>

Obraz zawierający rafa, Majorelle blue, Wielobarwność, sztuka

Opis wygenerowany automatycznie**Activity 8**

Definitions of key terms:

1. a Parasite is a form of antagonistic coexistence of two organisms, one of which benefits from the coexistence, and the other suffers damage. This term is used in biology - concerning two organisms of different species - and in sociology, where parasitism is called the idle lifestyle of a person able to work (from Wikipedia)

2. Parasitoids - organisms parasitizing other organisms (e.g., insects, plants, mites), sometimes killing their host. Sometimes the term parasitoid is a temporary parasite. They are organisms intermediate between predators and parasites, entering into antagonistic interactions with another species (larval parasitism). Then the parasitoid (insects, mainly from the order of flies and hymenoptera) lays its eggs in the body of an insect of another species. The larvae are parasites - they feed on the host's body without depriving it of life before pupation. Unlike most predators, parasitoids can be highly specialized. Parasitoids are used for biological pest control. (wikipedia)

3. Predation is sometimes defined as a way of eating organisms, using the body of another animal as food and, unlike parasitism, leading to the death of the victim. In ecology, it is treated as one of the antagonistic forms of interspecies (predator-victim) or intraspecific (e.g., cannibalism) relationships that developed in the course of coevolution (adaptation). Predator-victim systems and systems related to other interspecies interactions determine the distribution, balance, and structures of ecosystems (wikipedia)

Task:

In the light of the presented definitions, determine which ecological group the viruses belong to and construct an argument supporting your position.

**Lesson 5-6 Pathogenicity - virus vs. immune system**

Objectives

In terms of news

Student:

* gives the routes of transmission of viral diseases,
* lists the factors that weaken the immune system,
* lists viral diseases: rabies, AIDS, Heine-Medina, diseases caused by HPV infection, influenza, measles, smallpox, rubella, mumps, hepatitis A, B, and C,
* characterizes the symptoms of a viral infection,

In terms of skills

Student:

* proposes a definition of health and disease,
* designs an experiment examining the effectiveness of masks in preventing the spread of pathogens.
* evaluates the economic importance of plant and animal viruses.

In terms of attitudes

Student:

* shapes pro-health and prophylactic attitudes that protect against viral infections.

Methods

* Negotiating meanings, working in groups
* Wanted poster
* Case study
* Role-play
* Interview
* SWOT analysis

RECOMMENDED ACTIVITIES: 2, 3, 4, 6, 8

The course of the lesson:

**Activity 1**

The main issue to be debated: When are we sick and when are we healthy? Which means that someone is healthy, and what means that someone is sick?

The definition of disease and the definition of health - the relationship between the two terms.

Principles of work: Students (first individually) create definition cards of two concepts - health and disease, and stick their definitions on two sheets of paper (separate definitions of health and disease). In the next step, they look for common elements and discuss those that are only in individual cases. Ultimately, each group presents its own mutually agreed definition.

Key ideas:

A disease is a disorder of function or damage to the body's structure. A disease occurs when the action of the pathogenic agent causes undesirable symptoms that differ from the functions of a healthy organism. <https://pl.wikipedia.org/wiki/Choroba>

According to the definition by the World Health Organization - Health - is a state of complete physical, mental and social well-being. In recent years, this definition has been supplemented with the ability to lead a productive social and economic life and a spiritual dimension. Health is a pervasive issue.

We distinguish between physical, mental, emotional, social, and spiritual health. For an extended reading: <https://pl.wikipedia.org/wiki/Zdrowie>

Obraz zawierający rafa, Majorelle blue, Wielobarwność, sztuka

Opis wygenerowany automatycznie**Activity 2**

The main issue to be debated: What determines the health problems caused by viruses? What factors contribute to viral infections?

Students are asked to prepare a guide for other students informing them about risk factors and preventing viral diseases.

Key ideas and terms:

Virus virulence/virulence - The ability of a virus to cause disease in an infected host.

Viral infections often occur seasonally and cyclically. They depend on:

- the transmission pathway through which the virus spreads,

- periodic fluctuations in the host's immune defense,

\* The incidence of viral diseases also depends on:

- individual predispositions, build, gender, etc.

\* Viral pathogenesis is how a viral infection leads to disease.

Viral pathogenesis is an abnormal situation with no value for the virus. Most viral infections are subclinical. It is not in the "interest" of the virus to severely damage or kill the host. The consequences of viral infections depend on the interaction between many viral agents and the host.

The immune response to the virus is possibly the most influential in influencing the outcome of an infection. The virus is completely cleared from the body and completely healed in most cases. The immune response cannot completely remove the virus in other infections, and the virus persists. The immune response plays a significant pathological role in the disease of many infections. Overall, cellular immunity plays a major role in clearing up a viral infection, while humoral immunity protects against reinfection.

\* Paths of movement and spread of viruses:

- droplet pathway (e.g., influenza virus)

- digestive tract (fecal-oral route) (e.g., rotavirus)

- genitourinary system (sexual route) (e.g., HIV)

- direct route - by contact with mucous membranes (e.g., herpes virus)

- from an infected mother to the fetus via the placenta

- mediated by a vector from another person (e.g., animal) (e.g., dengue virus)

- blood-borne route (e.g., during blood transfusion) (e.g., HIV, HBV, HCV)

vector-mediated contact with the reservoir (e.g., tick-borne encephalitis virus)

Recommended additional materials:

Integrated Educational Platform

Keyword: Human viral diseases - types of infections, prevention, and treatment

Obraz zawierający rafa, Majorelle blue, Wielobarwność, sztuka

Opis wygenerowany automatycznie**Activity 3**

Problem: Do the masks give us something?

Dividing the class into two groups - those who think they are helpful and skeptical about the effectiveness of face masks. Then both groups are asked to provide arguments justifying the selected positions.

After listening to the arguments, the film is shown - masks:

<https://www.youtube.com/watch?v=DNeYfUTA11s> High-speed camera captures how different types of face masks work

Problem questions for classroom discussion: How does the infamous virus that paralyzed the world work? What can we do to prevent the development of the coronavirus pandemic in the future? What factors are contributing to the spread of this virus?

Film Screening: Coronavirus Film - Spread, Penetration Mechanism, etc.

<https://www.youtube.com/watch?v=I-Yd-_XIWJg&list=PLRuLO8d3L-MA5ieaZnVbGs6XIGzTlgiOX>

Obraz zawierający rafa, Majorelle blue, Wielobarwność, sztuka

Opis wygenerowany automatycznie**Activity 4**

**Activity 4a An additional form of activity recommended for teachers.**

Materials prepared for students in the form of printed information about viruses and viral diseases should be covered with foil and sprayed with water with dissolved powder - Fluorescein 200% (dye with approval). Using a UV flashlight at the end of the lesson, we can track how much the students spread the "virus" around each other.

**Required materials:**

- wrapped information about viruses

fluorescein 200%

water

UV flashlight

plastic bottle with an atomizer to distribute the dye solution

**Activity 5**

It is a task to be performed in a computer lab or as homework, as it requires Internet access.

Instruction for the student: Using the prepared infographics - presenting the idea of the arrest warrant and the example of this letter, prepare arrest warrants for the viruses that have hit your desk. You can use the information available on the Internet.

The wanted poster should contain the following information:

Virus Name:

Virus Photo:

Characteristics:

Route of spread:

Description of contact with the virus (symptoms):

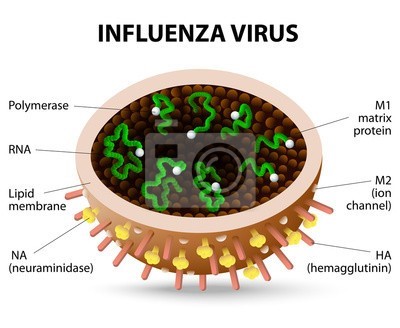
Viral diseases worth paying attention to are rabies, AIDS, Heine-Medina, diseases caused by HPV infection, influenza, measles, smallpox, rubella, mumps, hepatitis A, B, and C, some types of cancer;

**Additional information on rhinoviruses**

Rhinoviruses (from the Greek rhino - nose) is a simple virus whose genetic material (RNA) has ten genes. They are the most common viral infectious agent in humans, responsible for 30-50% of colds (Wikipedia). The virus spreads by airborne droplets (it quickly penetrates the droplets of liquid thrown out when sneezing or coughing). If you don't wash your hands, for example, when you touch a handkerchief, the virus spreads to everything you feel. If someone else touches it, they also have virions of this virus on their hands. After getting into the nose, rhinoviruses attach to the epithelial cells inside the nasal passages. Penetrating inside them, they force the epithelial cell to produce its genetic material and its proteins. The affected cell eventually ruptures (it is lysed), and new virus particles attack other cells or come out with liquid droplets when sneezing. As a rule, they strike a few cells - our malaise is caused by cytokines and the immune system's reaction. Since the epithelial cell produces new virus particles, it often makes mistakes; it is very variable and changes (mutating) rapidly. These changes cause our immune system to struggle to recognize the new versions of the virus (and not have the antibodies ready). As a result, even after one year, we can be infected by several different strains of rhinovirus, among others; for this reason, we still do not have effective medicines for colds - a runny nose treated lasts a week, untreated for seven days - there is something in it. 😊 (based on The Planet of Viruses by C. Zimmer).

**Additional information about the group virus**

Flu - "influential disease" (influenza in Italian means influence, the name derives from the fact that in the Middle Ages, there was a belief among doctors that the stars influenced patients' health). It is estimated that this virus attacks one billion people on Earth every year, and as a result of this attack, from 290,000 to 650,000 people die each year. Hippocrates already described it in 412 BCE. In 1918, there was an epidemic of this disease, which took 50 to 100 million people, which constituted 3–5% of the world's population. The genetic material of the influenza virus (RNA) has only 13 genes. Still, it is also characterized by a large genetic variability mainly related to mutations, such as the effect of carelessness in reverse transcriptase, which transcribes viral RNA into DNA. The virus's genetic material is contained in a lipid-protein envelope (nucleocapsid). The core consists of a nucleoprotein from RNA, and it is surrounded by the M protein, which is surrounded by a lipid envelope. The casing contains highly immunogenic glycoproteins haemagglutinin and neuraminidase.

The virus spreads by airborne droplets. When it gets into the nose or throat, it attacks the epithelial cells of these organs - it sticks to epithelial cells and penetrates inside. It forces cells to produce their genetic material and their proteins. The cell is lysed and destroyed, and new virus particles attack new epithelial cells that face the same fate. The flu usually passes after a few days due to the immune system, which produces antibodies that attack the virus's surface proteins (the virus uses these proteins to attach to cells and penetrate epithelial cells). Unfortunately, antibodies targeting one type of virus are not effective against the next version (resulting from a change in the virus's genetic material). This virus can spread through the respiratory system and "get" even to the lungs, weakening the natural defense mechanisms (destroying epithelial tissue) paves the way for other pathogens, thus leading to complications and lung infections. In such a situation, pathogens cross the lung barrier and spread throughout the body - or selected places in our body. This virus is so variable that new variants appear every year, so to protect themselves against it, people are willing to vaccinate themselves every year. Other animals, such as birds, are carriers of this virus strain. In these animals, the virus can, for example, attack the intestines, not the respiratory tract, and leave the bird's body together with the feces. Thus, it is a source of infection for another bird (e.g., how the droppings end up in the water). Sometimes the avian version of the virus attacks the human body. Most of these infections are harmless because the bird flu virus has different properties, and their set "does not work" in the human body. Most often, it also cannot spread from person to person. The situation changes when such an avian virus mutates. (e.g., as a result of an antigenic jump, the genetic material of the bird version is mixed with the genetic material of the human version, the resulting "hybrid" is potentially a much greater threat to our health). (Adapted from Planet of Viruses by C. Zimmer)

<https://www.youtube.com/watch?v=tMTl3gU0mFc&list=PLDtejNiUATM82I70CAGoLVgvjXr09DnQP&index=4> - bird and swine flu/ antigenic shift

<https://www.youtube.com/watch?v=Q9L7ZQPc8EA&list=PLDtejNiUATM82I70CAGoLVgvjXr09DnQP&index=11> - hepatitis A and B, attacking hepatocytes.

**Activity 6**

Obraz zawierający rafa, Majorelle blue, Wielobarwność, sztuka

Opis wygenerowany automatycznieMain problem: Do plants, and other animals also get viral diseases?

Should we focus on protecting against epidemics that threaten plants and not humans?

<https://thebiologist.rsb.org.uk/biologist-opinion/the-threat-of-a-plant-disease-epidemic>

Students take on the role of members of a food defense association. Their task is to prevent another pandemic that will cause losses to growers and growers.

They receive information packages on:

swine foot-and-mouth disease,

cucumber green mosaic virus

|  |  |
| --- | --- |
| Swine foot-and-mouth disease | |
| Virus | <https://pl.wikipedia.org/wiki/Wirus_pryszczycy>  Obraz zawierający grzyb, rafa, pleśń  Opis wygenerowany automatycznie |
| Map | Obraz zawierający tekst, mapa, atlas  Opis wygenerowany automatycznie |
| Losses | This paper estimates that annual impact of FMD in terms of visible production losses and vaccination in endemic regions alone amount to between US$6.5 and 21 billion. In addition, outbreaks in FMD free countries and zones cause losses of >US$1.5 billion a year |
| Description | <https://pl.wikipedia.org/wiki/Pryszczyca>  Foot and mouth disease [a]) - acute, very contagious viral disease of farmed and wild animals. In the European Union, including Poland, it is subject to notification and fight against ex officio.   It occurs all over the world. Currently considered the most dangerous disease of animals, its occurrence paralyzes world trade in animals and animal products. Its occurrence causes very large economic losses. Cattle, pigs, sheep, goats, buffaloes, reindeers, camels, wild boars and wild ruminants are susceptible to the infection. Susceptibility to infection varies within the same species.    <https://www.wetgiw.gov.pl/nadzor-weterynaryjny/o-pryszczycy>    About foot-and-mouth disease, the ways of infection and the protection of animals against disease  Foot and mouth disease (FMD) is an infectious and contagious disease of domestic and wild cloven-hoofed animals. Cattle are most susceptible to infection, followed by pigs, sheep and goats. The disease is caused by a virus of the genus Aphtovirus belonging to the Picornaviridae family.  The country where FMD occurs is exposed to very large economic losses in the meat industry and breeding. These losses are caused by the deaths of animals from susceptible species, the costs of eliminating disease outbreaks and compensations paid, as well as the suspension of trade and export of animals from susceptible species, meat of these animals and products obtained from these animals.  Humans are susceptible to infection, however foot-and-mouth disease in humans is not fatal and is usually mild. People become infected through direct contact with a sick animal, as well as by consuming meat, milk and unpasteurized dairy products from an infected animal.    Dear infection    The virus is excreted by the infected animal before it develops disease symptoms. Infected and sick with foot-and-mouth disease animals shed the virus in the exhaled air, in their secretions and excreta. The greatest concentration of the virus is found in the serum fluid and epithelium of emerging blisters. Animals can carry the virus for up to three years.    Sources of infection:    sick or stored animals,  saliva, milk and its products, feces, fodder, water, mangers, floors, pastures, leather, wool, hands and clothes of the operator,  meat and its products,  semen and embryos,  means of transport, rodents, birds, insects,  kitchen waste.  Protection of animals against disease    In order to protect the herd from the entry of the foot-and-mouth disease virus, it should be remembered that the animals entering it come from a known source and are accompanied by a health certificate confirming their origin and health status. |
| Source | <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3989032/> |

|  |  |
| --- | --- |
| Cucumber green mosaic virus | |
| Virus | Obraz zawierający zrzut ekranu, sztuka  Opis wygenerowany automatycznie |
| Distribution | CGMMV is a virus classified as Tobamovirus. It was first described in 1935 in Great Britain. In the years 1935–2006 it gradually spread throughout Europe. Its presence was found, among others in: Denmark, Germany, Russia, Finland, the Netherlands, Ukraine and the former Yugoslavia. In the years 2007–2021, the virus spread strongly in countries where it was previously observed and reached South and East Asia. It was also recorded for the first time in Poland. In 2013–2021, it reached Canada and the USA in North America, as well as Australia. Currently, it is found on all continents except South America.  Obraz zawierający mapa, tekst, atlas, zrzut ekranu  Opis wygenerowany automatycznie |
| Losses | “Yield is reduced by 25% even more if no control actions are taken into account. In the epidermis of the sick plants characteristic structures can be seen easily with a microscope.”  Obraz zawierający owoce, Naturalne jedzenie, produkcja, arbuz  Opis wygenerowany automatycznie |
| Description | Cucumber mosaic virus (CMV) is a common plant virus that is transmitted by aphids and causes large yield losses of various crops each year. The virus produces a protein called 2b that attacks the plant's immune system, allowing the viral infection to spread.  The symptoms of CGMMV infection are fairly easy to identify. The leaves have characteristic light and dark green mosaic-like spots, moreover, bubbles are formed on them and the leaf blades are deformed. Plant growth is stunted, the buds may die and sometimes the fruit may become distorted, although symptoms vary depending on the variety. Often the symptoms disappear as the leaves age. When infection occurs on young plants grown under high light conditions, they may wilt. These symptoms are easily confused with Pythium soft root rot, but with viral infection, the roots are healthy and leaf wilt is most evident in the center of the plant. Low temperature and light intensity in spring intensify the symptoms. |
| Source | <https://www.warzywa.pl/warzywa-pod-oslonami/czy-wirus-zielonej-mozaiki-ogorka-cgmmv-jest-zagrozeniem-dla-polskich-upraw/> |

In the packages, the map of the occurrence and spread of the virus, the historically proposed fighting methods - choose one of them and then have to trace which was effective.

The student's task is to prepare a 3-minute press conference recording. They will summarize - how the virus works, what costs we incur in connection with infections, and what actions we plan to take to reduce financial losses.

Additional materials:

1. Global pandemics and epidemics of plant viruses:

<https://pubmed.ncbi.nlm.nih.gov/33504044/>

B) Plant viruses overview and disease management:

<https://www.frontiersin.org/articles/10.3389/fpls.2020.01092/full>

C) Mouth and hooves disease: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3989032/>

D) Plant viruses: <https://www.totylkoteoria.pl/roslinne-wirusy-bakulowirusy/>

**Activity 7**

The game - is a puzzle

Student activity - choose the name of the disease with the name of the virus and the description.

The scatter pattern is below.

|  |  |  |
| --- | --- | --- |
| SWINE FLU | A/H1N1 | Infectious respiratory disease in pigs. In humans, infection with the virus occurs through direct contact with an animal. On June 11, 2009, WHO announced the highest threat level, representing a pandemic. More than a year later (August 10), the World Health Organization announced the end of the pandemic. The disease symptoms are high fever, headache, sore throat, muscle aches, runny nose, diarrhea, confusion, and loss of consciousness. |
| Chickenpox | herpeswirus 3 HHV-3 | Human is the only reservoir and source of the virus. Infection occurs through droplets and direct contact. The hatching period of the virus is 10-21 days, and then the virus multiplies - the effect is the involvement of the skin and the appearance of characteristic blooms. The recurrent (secondary) form is shingles. |
| MUMPS | MUMPS VIRUS | A viral disease that mainly affects school-age children. The infection occurs most often in winter and early spring. The droplet route is widened or through the saliva on the food. Very often, there are no symptoms of the disease. In the asymptomatic course, swelling of the parotid glands may occur, causing pain when opening the mouth or biting. |
| RUBELLA | RUBELLA VIRUS   (WIRUS RÓŻYCZKI) | Infectious disease of childhood, spread by airborne droplets. Surviving the disease causes permanent immunity. Red spots appear on the skin during the illness, which eventually merges into one (red skin feeling). Lymph nodes grow in size and are painful to touch. Wounds appear in the mouth. |
| AIDS | HIV | The final stage of infection with a virus transmitted through contact with the patient's blood or mucosa (e.g., using the same needles, sexual contact). The immune system is wiped out, leading to numerous diseases (called indicator diseases) - e.g., mycoses, pneumonia |
| MEASELS | MEASELS VIRUS | Childhood rash disease. The infection spreads through droplets - the virus enters the body through the nasopharynx. A characteristic feature is a whitish discoloration appearing on the mucosa of the cheeks, and there is a pink rash. |
| HEINE - MEDINA  DISEASE | POLIO  VIRUS | The virus enters the body via the fecal-oral route. The disease is usually asymptomatic. The full-blown disease leads to disturbances in the nervous system, which causes disruptions in skeletal muscle innervation and muscle atrophy. |
| RABIES | RABIES VIRUS | The route of infection is direct contact with the saliva of an infected animal. The name derives from the course of one of the most discernible forms of the disease, which is characterized by excitement and aggression (rage). Both wild and domestic animals are a reservoir of germs. The virus travels to the nervous system from the site of its invasion (e.g., the wound). Examples of symptoms are drooling and hydrophobia. |
| SEVERE ACUTE RESPIRATORY SYNDROME | VIRUS SARS | The primary host is Chinese grace. The first human disease occurred in 2002 in China, and then the disease spread to other Asian countries, finally reaching other countries of the world by air travel. The infection is usually caused by droplets but also through contact with the feces of a sick person. Initially, the symptoms resemble flu, but the shortness of breath occurs in the latter stages of the disease (connection to a ventilator is necessary). |
| VARIOLA VERA | VARIOLA VIRUS | Human is a reservoir of the virus. The infection occurs through various routes: by droplets, contact with lesions on the patient's skin, bed linen of a sick person, or medical equipment. Viruses travel to the lymph nodes, spleen, and marrow. A characteristic symptom is a rash that turns into scabs that fall off, leaving unsightly scars. The last natural case of the disease was diagnosed in 1977 - it is the only human disease recognized by the WHO in 1980 as completely eradicated. |
| HEPATITIS A | HAV | The so-called food jaundice. Infection occurs through the gastrointestinal tract, contact with the patient's secretion, and infected products—dirty hands disease. The disease symptoms are vomiting, abdominal pain, anorexia, and low-grade fever. |
| HEPATITIS B | HBV | The way of infection is direct contact with the sick person (their body fluids). Most cases are self-healing. However, the chronic condition can lead to jaundice, cirrhosis, and even death. |
| HEPATITIS C | HCV | Infection is a result of direct contact with the patient's blood. The characteristic symptoms are fatigue, nausea, and weight loss. Jaundice occurs in the acute phase. In 80% of those infected, the disease becomes chronic, and cirrhosis and liver cancer may develop over many years. |

**Activity 8**

Obraz zawierający rafa, Majorelle blue, Wielobarwność, sztuka

Opis wygenerowany automatycznieMain problem: Are we alone in the fight against the virus?

In addition to our immune system, some drugs can support the work of our system.

Analysis of the content of the article:

Antiviral drugs and interferons:

<https://bioinfo.imdik.pan.pl/coronavirus-service/mesmerize/leki-prawywirusowe/>

Key ideas:

Flu and interferon - medicine worse than the disease? Why do we use antiviral drugs less frequently than antibiotics against bacteria?

Students construct a decision tree in an attempt to resolve this dilemma.

Designing new and effective antiviral drugs is difficult because viruses multiply inside cells using cellular enzymes, organelles, and macromolecules. For this reason, antiviral preparations must be precise to the virus and should not harm the host. Unfortunately, with many antiviral drugs, side effects often occur. Most antiviral drugs are designed to act as an essential step in replicating a particular virus. Therefore, they are usually only effective against the specific virus and viruses closely related. Antiviral drugs often target viral enzymatic proteins with properties different from cellular proteins, such as reverse transcriptase, integrase, or particular proteases.