TEACHER LESSON PLAN

Lesson 2 – Ecology of Disease: Comparing Viruses, Bacteria, and Eukaryotes

LESSON QUESTIONS

- How do scientists characterize interactions between organisms?
- What are the similarities and differences between diseases caused by viruses, bacteria, and eukaryotic microorganisms?

LESSON OBJECTIVES

- Analyze and characterize ecological interactions between organisms.
- Distinguish diseases caused by viruses, bacteria, and eukaryotic microorganisms.

DOK 1 – 4

OVERVIEW

In this lesson, students identify patterns of ecological interactions. The lesson focuses on how disease is part of the natural ecosystem and the relationship of disease to human activities and well-being. Students first read a passage about ecological relationships between organisms. They identify different types of relationships as predation, competition, parasitism and so on (DOK1). Students use a worksheet to classify and organize this information. They use the information to show why a given relationship is so characterized (DOK2). For example, a student would cite evidence that *Plasmodium spp*. is parasitic (DOK3). (Various types of *Plasmodium* cause malaria.) Working in groups, students identify mosquito-borne diseases from a list of common diseases.

Groups research a chosen mosquito-borne disease. They collect data on its life-cycle and other data such as geography, prevalence and control (DOK1). As a summative assessment, the teacher uses a Truth or Myth strategy. This approach helps students develop critical thinking about causes and effects of ecological interactions. In this activity students cite evidence to support their claims (DOK3). As an extension, students create a media resource. The media resource is designed to inform concerned citizens about issues related to the disease they chose to research (DOK4).

LENGTH

Up to two 45 minute sessions

GLOSSARY TERMS

virus, bacteria, eukaryote, pathogen, mosquito, infection, commensalism, parasitism, predation, competition, mutualism, amensalism, symbiosis, vector

STANDARDS

- **Next Generation Science Standards**
    - MS-LS4-4. Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment.
    - MS-LS4-6. Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time.
- **Common Core State Standards**
    - RST.6-8.2 Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.
    - RST.6-8.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6-8 texts and topics.
    - RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).
    - RST.6-8.8 Distinguish among facts, reasoned judgment based on research findings, and speculation in a text.
    - RST.6-8.9 Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

MATERIALS

- Computer with internet access

BACKGROUND FOR TEACHER

The goal of this lesson is to introduce students to the ecology of disease by comparing interactions between viruses, bacteria and eukaryotic microorganisms. Germ theory, first proposed in the 16th century, provides the scientific background. In the 19th century, French scientist Louis Pasteur brought a scientific perspective to disease. As microscopy developed, observations confirmed ideas about disease being caused by microscopic biological agents. Prior to these advances, people had other ideas to explain disease, such as "bad air" (hence the word "mal-aria"). Epidemiology also helped scientists to identify the causes of disease. For example, the 1854 Broad Street cholera epidemic in London was traced to a single contaminated communal well. This finding led to the understanding of bacteria as a cause of disease. Viruses were discovered in the late 19th

century. Scientists have described several thousand viruses, although millions are known to exist—there are several types of viruses for all known organisms. Disease can also be understood as an ecological interaction. Disease can affect an entire ecosystem. For example, Dutch elm disease is caused by a fungus that is spread by beetles. The disease killed more than 25 million elm trees in the UK, and 90 percent of France's elm trees were lost to the disease. Such losses have a domino effect with consequences for other organisms. For example, scientists have documented the changes in elm populations on nesting birds. In this context, disease is an ecological phenomenon. This view may help some students to engage with the content and to see that diseases can have effects beyond those on the infected or diseased organism.

TEACHER NOTES

The over-arching question of this lesson is what ecological interactions occur between disease organisms and their hosts? In completing the lesson, students will be able to identify and distinguish between different types of ecological interactions. Students apply these concepts to compare diseases caused by viruses, bacteria and eukaryotic microorganisms. The key learning point is for students to connect the abstract concept of ecological interaction with evidence of disease. This connection is then applied to enable students to draw conclusions about how disease impacts human activities and well-being. Students may be familiar with the names of various diseases such as "flu" or Zika. Probe prior knowledge to determine the extent of students' understanding of the different kinds of organisms that cause disease. Students should at least be familiar with the terminology related to disease, infection and disease-causing agents.

Use a think-pair-share strategy in Explain: (1) Ask questions for students to think about individually. (2) Students work in pairs or small groups. (3) Student pairs share their thinking.

LESSON RESOURCES

- Lesson animation
  - *How do Viruses Reproduce?* https://vimeo.com/227177718

- Reading passage:
  - *Exploring Ecological Interactions*

ENGAGE

1. Show the video *How do Viruses Reproduce?* to the class.
2. Ask students to write three words to describe the interaction between the virus and the cell.

3. Explain to the class that scientists characterize interactions between organisms and that such interactions can be considered positive, neutral or negative.
4. Tell students that they will explore these ecological interactions in terms of diseases caused by viruses, bacteria and eukaryotic microorganisms.

EXPLORE

1. Students read the passage, *Exploring Ecological Interactions*.
2. If necessary, struggling or ESL students can work in pairs to read the passage. (This approach will support the think-pair-share strategy in Explain.)
3. Students work in small groups to brainstorm various kinds of ecological interactions with which they may be familiar.
4. In their groups, students research online to find at least one additional example of each type of ecological interaction. Ensure that each of the six ecological interactions listed on the student worksheet are covered by at least one group.
5. For each example, students complete the worksheet table to list:
    a. Each species involved
    b. The type of interaction
    c. The effect (positive, negative, neutral) of the interaction on each species involved

EXPLAIN

1. Use the think-pair-share strategy (see Teacher Notes) to enable students to explain their understanding of the passage.
2. Students answer the ecological interaction questions in the worksheet.

ELABORATE

1. Students work in groups to choose one mosquito-borne disease and research online to gather information. Information should focus on the ecological interactions between the host, disease-producing organism and vector (e.g., the disease-producing organism-host relationship may be parasitic, while that between disease-producing organism and vector may be commensal).
2. Have students choose a disease from the following options or assign one to each group:
    - Zika virus
    - Yellow fever virus
    - Malaria
    - Dengue virus
    - Japanese encephalitis virus
    - West Nile virus
    - Kokobera virus
    - Chikungunya virus
    - Equine encephalitis

3. Groups create a concept map. The concept map should include the life-cycle of the host, disease-producing organism and vector (if appropriate) and indicate the ecological interactions with host and vector species.

EVALUATE

1. Each student group exchanges its concept map with another group's. Groups critique the others' concept maps, offering suggestions and constructive criticism.
2. For individual summative assessment, use the Truth or Myth strategy. Students answer questions true or false and then cite evidence to support their response. Refer to rubric.

EXTENSION

Students work in groups to create a media resource to educate non-experts about their chosen disease. The resource should include a summary of information from the concept map and relate this information to methods of preventing the disease and its effects.

RUBRIC: STUDENT WORKSHEET

Ecological Interactions Table

Organism 1	Effect + or -	Organism 2	Effect + or -	Type of interaction
Dung beetle	+	Buffalo	n/a	commensalism
Buffalo	n/a	Insect	-	amensalism
Gut bacteria	+	Buffalo	+	mutualism
Oxpecker	+	Buffalo	+	mutualism
Tsetse fly	+	Buffalo	-	parasitism
Lion	+	Buffalo	-	predation
Insects	-	Oxpecker	+	predation
Zebra	-	Buffalo	-	competition

Ecological Interaction Questions

1. Why is the relationship between the dung beetle and buffalo an example of commensalism?

    - The beetle benefits; the buffalo is unaffected.

2. What is an example of mutualism in the passage?

    - Gut bacteria and large herbivores are one example. The Oxpecker and buffalo, another.

3. Why would you consider the tsetse fly to be a parasite?

    - It feeds on blood negatively affecting the host while the tsetse benefits.

4. What is the difference between a predator and a parasite?

    - A predator usually kills off the other organism; a parasite often does not. There are exceptions since some parasitic diseases, such as malaria, are often fatal.

Assessment Questions

1. An ecological interaction is one in which both species benefit.

    - **Myth**
      Several types of ecological interactions exist. In some of these, one species may not benefit at all or may be harmed.

2. Parasitism and infection (by a disease-causing agent) are examples of ecological interactions.

    - **Truth**
      An ecological interaction occurs whenever one species affects another. Since parasites and disease-causing agents affect their hosts, they can be considered ecological interactions.

3. The disease malaria is caused by a parasite that is injected with a mosquito's saliva when the mosquito bites someone. In this case, the mosquito is also considered to be a parasite.

    - **Truth**
      The mosquito benefits from feeding on a person. The person can be harmed by the mosquito. Therefore, the mosquito is a parasite.

4. The relationship between the acacia and the ant is an example of commensalism.

    - **Myth**
      The relationship between the acacia and the ant is an example of mutualism, not commensalism. In this case, both the ant and tree benefit. A relationship is defined as commensalism when only one species benefits.