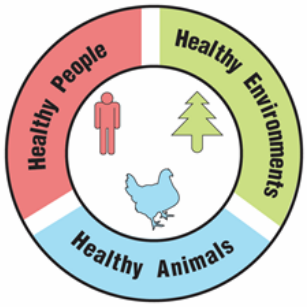
LSLC Virtual Field Trip – Teacher Guide

Mysterious Case of Brain Illness



Virtual Field Trip Summary:

Doctors, environmental investigators, and veterinarians work together to identify the cause of an outbreak of encephalitis (a brain illness). What actions could prevent future outbreaks and protect the health of people, animals, and the environment?

Core Concepts:

- Mosquito-borne viruses pose a growing risk to human and animal health.
- Mosquito control may reduce human health risks.
- A One Health approach identifies and seeks solutions to problems that affect the health of humans, animals, and the environment.

Suggested Grade Levels: Grades 7 – 8

Time Required (approximately 155 – 180 minutes):

Introduction

Home Page Content – Video Introduction and Digital Lab Notebook downloads **15 minutes**

Basic Content

Part 1 – What is causing an outbreak of encephalitis? **20-25 minutes**

Part 2 – Is there a link between bird deaths and the encephalitis outbreak? **40-45 minutes**

Part 3 – How is the West Nile virus transmitted and spread? **30-35 minutes**

Advanced Content

Part 4 – Should people spray insecticides to prevent the spread of West Nile virus? **30 minutes**

Part 5 – One Health and the West Nile virus **20-25 minutes**

Extension Content

Extension Activity – Mini Project to reinforce One Health concepts. **Time will vary.**

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Teacher Preparation:

Simulations of laboratory techniques are used. Consider discussing the importance of laboratory safety. Use this as an opportunity to review your school's Chemical Hygiene Plan and reinforce relevant laboratory safety procedures with your students. Online videos can be used as a visual review. Here is a link to an example: https://youtu.be/MEIXRLcC6RA

Materials/Supplies Overview:

1. Electronic devices for accessing the internet individually or in groups. Provide access to:
    - Google (Docs, Google Slides, Jamboard, etc.). If needed, convert these programs into another platform such as Microsoft products (Word, PowerPoint, etc.)
    - PowerPoint or similar digital program for making slides, or poster paper and markers.
2. Confirm that you have access to the **Mysterious Cases of Brain Illness Virtual Field Trip** website. Click the link below to preview the virtual field trip to become familiar with the website: https://sites.google.com/view/outreachprogramsvft02/home
3. Link for **Digital Lab Notebook** that serves as an answer sheet, data collection tool, and record of their virtual lab activities. The Digital Lab Notebook can also be used for extra credit assignments. **Each student will need to make their own copy of the Digital Lab Notebook**:

    https://docs.google.com/presentation/d/11Oai5OO2VDaxwwT55q7jNx7lX3HiDxXf5MuEC9rrPpE/copy

    Note: Provide the PowerPoint version of the **Digital Lab Notebook** for students who do not have access to Google Slides.

General Information:

1. Read Suggested Procedures section of this guide for each part.
2. Some parts of the virtual field trip have multiple videos embedded within the website. Play each video to preview information and content before use with students.
3. Answer Keys have been included in this Teacher Guide. Review the answer keys.
4. Share the link for the **Mysterious Cases of Brain Illness Virtual Field Trip** with each student.
5. Share the link or provide printed copies of the **Digital Lab Notebook**.
6. Students can work individually or in pairs to complete this virtual field trip.
7. The virtual field trip can be completed within the time schedule preferred by the teacher. It should be completed in sequential order - Part 1, before Part 2, and so on.

(Optional) Parking Lot Suggestion:

The topic of this virtual field trip is rich enough to trigger conversations and questions that go beyond the immediate content in this lesson. Teachers may set up a "Parking Lot" for collecting student questions or ideas for additional connections/research. If participation in the virtual field trip is done with video conferencing formats, breakout rooms or a Google Jamboard can also be used for this Parking Lot Strategy in place of using sticky notes and poster paper.

Parking Lot Strategy

- Make a large poster paper or bulletin board area in the classroom as your Parking Lot.
- When students have a question or additional connection, have them write it on a sticky note and hand it to you or put it in the Parking Lot.
- Only answer questions immediately if they are essential for completing the lesson.
- Put sticky notes with other questions or connections in the Parking Lot.
- At the end of the lesson, review the Parking Lot questions.
- Remove questions that were answered by the lesson.
- Ask students which remaining questions and connections they would like to discuss.

(Optional) Team Science Suggestion:

Teachers can introduce the concept of **Team Science** if students will be working in groups. **Team Science** is a popular approach in research where large projects are divided among individuals as they work in one or more groups to solve problems. For more on team science: https://www.apa.org/science/about/psa/2013/04/team-science.

To promote additional student engagement during each part of the virtual field trip, a different set of students can volunteer or be assigned to the roles below. Alternatively, a set of students working in a small group can be assigned or given a role for their group. *If you identify additional roles for promoting student engagement, describe them in your Teacher Evaluation feedback.*

1. **Timekeeper:** Student who will keep track of time allowed and spend on each part. The teacher will provide the Timekeeper with the time limit for the virtual field trip part. The Timekeeper is given a physical timer to monitor time or is provided access to a clock. The Timekeeper should be given a printed copy of the ***Mysterious Case of Brain Illness Virtual Field Trip Log*** (see page xiii) and pencil or pen to record the actual time spent on the part. If more time is needed than allotted, the teacher can choose to provide more class time to finish, or direct students to complete the rest during out of school time. Timekeeper then announces to the class the total time that will be provided for the "Part" of the virtual field trip. For example, this can be done by saying,
    - *I am the Timekeeper for Part 1. Our 20 minutes for Part 1 begins now!*
    - *We have 5 minutes left in Part 1,*
    - *We have 1 minute left in Part 1,*
    - *Part 1 is finished, click the "Next Page" button on the bottom of your screen.*

2. **Recordkeeper:** Student who will remind the class to record their responses in their Digital Lab Notebooks following each question/activity. When the Timekeeper announces 5 minutes left, the Recordkeeper can follow the announcement by saying,

    - *Remember to record your data and observations in your Digital Lab notebook.*

    When the Timekeeper announces the end of Part 1, the Recordkeeper can say,

    - *Make you sure all Part 1 responses are in your Digital Lab Notebook.*

    Note: *For those using a Google Slide version, the Digital Lab Notebook is "autosaved" to the student account. If using a PowerPoint version of the Digital Lab Notebook, the Recordkeeper can also remind students to save the file. This will prevent loss of data. The following announcement can be made,*

    - *Click "save" in your Digital Lab Notebook before moving to the next part.*

Suggested Procedures (Parts 1-5):

Homepage: Introduction

1. Share **Mysterious Cases of Brain Illness Virtual Field Trip** website link with each student: https://sites.google.com/view/outreachprogramsvft02/home
    - Teachers can screen share to show students the website before the students work independently or in groups.
    - Teachers should direct students to watch the **Introduction Video** at the top of the **Homepage**. Dr. Alcéna-Stiner, from the Life Sciences Learning Center, provides an overview for the field trip in the video. For this **Introduction Video** and all additional videos in the virtual field trip:
        - The teacher can play the video on a Smartboard or similar option to project the video for the entire class.
        - Make sure to turn audio on and adjust volume accordingly.
        - Students who are working independently have an option to read the text in the video and/or listen to the text being read aloud.
        - Students who do not want the audio in in the videos played can simply mute or adjust their audio volume.
2. Teachers should explain that the virtual field trip has **five parts**. Students are about to participate in **Part 1: What is causing an outbreak of encephalitis?**
3. The website will guide students through each part of the **Mysterious Cases of Brain Illness Virtual Field Trip**
    - If students are using a mobile device and not a computer, they may need to scroll downward or across to view content based on the size of their screen.
4. Students are provided a link to download their own **Digital Lab Notebook** (see bottom of Homepage): https://docs.google.com/presentation/d/11Oai5OO2VDaxwwT55q7jNx7lX3HiDxXf5MuEC9rrPpE/copy
    - Teachers can have students share their individual **Digital Lab Notebook** links for grading or extra credit for participating in the activities.

Part 1: What is causing an outbreak of encephalitis? (20 minutes)

1. Teachers should explain that the virtual field trip has **five parts**. Students are about to participate in **Part 1: What is causing an outbreak of encephalitis?**
2. Direct students to watch Video 1 in the **Mysterious Cases of Brain Illness Virtual Field Trip**.
3. After watching the video, tell students that this activity is based on actual events that occurred in New York State in 1999. Students can hear stories from real patients after the complete Part 1.
4. Ask a student to read the question under **Video 1** aloud to the class, or within a group:
    - How did the work of environmental health investigators help the doctors understand what might be causing the encephalitis outbreak?
5. Teacher or Recordkeeper reminds students to use their Digital Lab Notebook to record responses.
6. After students record their answers, they are directed to scroll down to the next video.
7. Repeat the process of watching the video, reading the question(s), and recording responses for video 2-5.

    Note: Video 3 has a virtual simulation of a virus test kit. Students must view the entire video to collect data. The video provides the information needed to interpret the results. Therefore, students do not need prior knowledge of the immune system. At the end of the video, students simply look at the circles and record the name of the virus listed above the circle that turned pink.
8. When Part 1 time ends or students have completed Part 1 responses in their Digital Lab Notebook, the teacher or Timekeeper reminds students to click "Next Page" at the bottom of the screen.
9. At the top of the new page, students are informed that they will start **Part 2** when their teacher gives access.
10. Students who finish Part 1 ahead of the class can keep learning on their own using the link(s) provided on this page.
    - **Centers for Disease Control and Prevention (CDC)** - One Health https://www.cdc.gov/onehealth/index.html
    - **Encephalitis Society** – Patient story videos. Most videos are approximately 9 minutes long. https://www.encephalitis.info/what-is-encephalitis.

    Note: Exploring content from the link(s) provided will add additional time for the virtual field trip. Teachers with limited time can have students explore link(s) outside of school time.
11. To begin Part 2 simply have student click "Next Page" at the bottom of the screen.

Part 2: Is there a link between bird deaths and the encephalitis outbreak? (40 minutes)

1. Direct students to access Part 2 of the **Mysterious Cases of Brain Illness Virtual Field Trip** website.
    - Students can click "Next Page at the bottom of the current page or if they are returning to the website homepage have them select "Part 2" from the sidebar/dropdown menu on the left.
2. Direct students to watch **Video 6** in the **Mysterious Cases of Brain Illness Virtual Field Trip**.
3. After watching the video, ask a student to read question 4 under **Video 6** aloud to the class, or within a group:
    - Why did the veterinarians conduct genetic tests on viruses from the brains of the dead birds?
4. Teacher or Recordkeeper reminds students to use their Digital Lab Notebook to record responses.
5. After students have recorded their answers, they are directed to scroll down to view the sequence of letters that represent part of an RNA molecule from the virus that killed one of the birds.

AGUAGUGUUU GUGAGGAUUA ACAACAAUUA

6. Students must compare this sequence of letters with the sequences of letters on the **Known RNA Sequences for Four Viruses Carried by Mosquitoes** sheet.

    Note: Students can complete this by simply looking at patterns. They do not need prior knowledge of DNA and RNA.
7. To "unlock" and access the **Known RNA Sequences for Four Viruses Carried by Mosquitoes** sheet, students must solve an interactive puzzle.
8. The puzzle is embedded within the website. Have a student read the **Puzzle Instructions** aloud to the class, or within a group.
9. After completing the puzzle, students can also view the full sheet by clicking the "Click Here to review the RNA sequences you unlocked" box.
10. Teacher or Recordkeeper reminds students to use their Digital Lab Notebook to record responses.
11. Ask a student to read the information in the first **Additional Information** text box aloud to the class. Then view the diagram below it. Alternatively, the audio player can be used for students to hear the text for the Additional Information and diagram read aloud.
12. After reading the text and/or listening to the audio, ask a student to read number 6 aloud to the class, or within a group:
    - Why did the veterinarians conduct genetic tests on viruses from the brains of the dead birds?
    - Students may need a hint for answering question 7. An easy way to provide a hint is to direct them to look at the animated part of the diagram. This is a moving circle highlighting the binding site/antigen area of the illustrations.
13. Have student read the "Read and Click" text box.
14. After reading the "Read and Click" text box, have students click the text to reveal an RNA molecule from a virus that caused the outbreak of human encephalitis.
15. Ask two or more students to read the remaining questions (7a, 7b, 8) at the bottom of the page aloud to the class, or within their group.

16. When Part 2 time ends or students have completed Part 2 responses in their Digital Lab Notebook, the teacher or Timekeeper reminds students to click “Next Page” at the bottom of the screen.
17. At the top of the new page, students are informed that they will start **Part 3** when their teacher gives access.
18. Students who finish Part 2 ahead of the class can keep learning on their own using the link(s) provided on this page.
    - **Centers for Disease Control and Prevention (CDC)** - One Health https://www.cdc.gov/onehealth/index.html
    - **Centers for Disease Control and Prevention (CDC) - One Health** https://www.cdc.gov/onehealth/index.html
    - **Centers for Disease Control and Prevention (CDC) - West Nile Virus** https://www.cdc.gov/westnile/index.html
    - **Centers for Disease Control and Prevention (CDC) – Mosquito Life Cycle** https://www.cdc.gov/westnile/resources/pdfs/FS_MosquitoLifeCycle-508.pdf
    - **Centers for Disease Control and Prevention (CDC) – Mosquito Control** https://www.cdc.gov/westnile/vectorcontrol/index.html
19. To begin Part 3, simply have student click “Next Page” at the bottom of the screen.
20. After students have recorded all data in their Digital Lab Notebooks, they are directed to click “Next Page” on the bottom right of the screen.

Part 3: How is West Nile virus transmitted and spread? (30 minutes)

1. Direct students to access Part 3 of the **Mysterious Cases of Brain Illness Virtual Field Trip** website.
    - Students can click "Next Page at the bottom of the current page or if they are returning to the website homepage have them select "Part 3" from the sidebar/dropdown menu on the left.
2. Explain that the text boxes and illustrations in Part 3 provide information that they will need to answer the questions (9-18) in their Digital Lab Notebooks. They may read the questions first and then go back to the text boxes to look for the answers.
3. Students can be encouraged to work with one or more partners to complete Part 3.
4. Ask students to volunteer to read the information in each text box aloud to the class, within their group or individually.
5. Teacher or Recordkeeper reminds students to use their Digital Lab Notebook to record responses.
6. Teacher or Timekeeper reminds students to click "Next Page" at the bottom of the screen.
7. The last page directs students to learn more using the links provided.
    - Students are informed that they will start **Part 4** when given access from their teacher.

Part 4: Should people spray insecticides to prevent the spread of West Nile virus? (30 minutes)

1. Direct students to access Part 4 of the **Mysterious Cases of Brain Illness Virtual Field Trip** website.
    - Students can click "Next Page at the bottom of the current page or if they are returning to the website homepage have them select "Part 4" from the sidebar/dropdown menu on the left.
2. Explain that the text boxes and illustrations in Part 4 provide information that they will need to answer the questions (19-25) in their Digital Lab Notebooks. They may read the questions first and then go back to the text boxes to look for the answers.
3. Students work individually to read the two-page simulated news article. Using the instructions in their Digital Lab Notebook, they should underline benefits, then highlight or circle risks. If they are working with a partner, consider:
    - Assigning one student in each pair to identify the benefits and the other student to identify the risks.
    - Having both students work individually to identify benefits and risks. Then, partners compare/discuss what they have underlined, highlighted, or circled.
4. Students can be encouraged to work with one or more partners to complete rest of Part 4.
5. Teacher or Recordkeeper reminds students to use their Digital Lab Notebook to record responses.
6. Teacher or Timekeeper reminds students to click "Next Page" at the bottom of the screen.
7. The last page directs students to learn more using the links provided.
    - Students are informed that they will start **Part 5** when given access from their teacher.
8. Optional Debrief: Divide class in half. One-half of the class presents information that supports spraying. The other half of the class presents information that opposes spraying.
    - Encourage use of reliable sources of information using the resource links provided.

Part 5: One Health and the West Nile Virus (20 minutes)

1. Direct students to access Part 5 of the **Mysterious Cases of Brain Illness Virtual Field Trip** website.
    - Students can click "Next Page at the bottom of the current page or if they are returning to the website homepage have them select "Part 5" from the sidebar/dropdown menu on the left.
3. Explain that the text boxes and illustrations in Part 4 provide information that they will need to answer the questions (26-27) in their Digital Lab Notebooks. They may read the questions first and then go back to the text boxes to look for the answers.
4. Read the information in the "One Health" text box aloud to the class. Alternatively, ask a student to read the information aloud or within a group.
5. Students work with their partner(s) to complete question 26.
6. Have several students share their answer to question 26. It is important for students to have the correct answer before moving on to question 27.
7. Read the information in the "Why are West Nile viruses a One Health problem?" text box aloud to the class. Alternatively, ask a student to read the information aloud or within a group.
8. Students work with their partner(s) to design a Digital Slide. Consider modeling how to complete the Digital Slide by showing the students how they can insert data and information into the templates provided in their Digital Lab Notebooks.
9. Suggestion – Collect digital slides into one slide deck. Share this slide deck with the class. If you have ample class time, you may consider having students present and explain their slide.
10. Students receive full credit if their slide links West Nile virus to the health of humans, animals, and the environment.
    - Optional extension: Have students identify another example of a One Health problem. Have students use their idea to create a similar digital slide that explains why their example is a One Health problem.
    - After students have recorded all responses in their lab notebooks, they are directed to click Next Page on the bottom right of the screen.
11. The last page asks students to provide their feedback on this virtual field trip, using the **Mysterious Cases of Brain Illness Virtual Field Trip Student Evaluation** form. Guide students to complete and submit the evaluation form.

    Student evaluation form: https://redcap.link/2022-LSLC-VFT2-Student_Feedback

    Note: Students will be asked to "Enter your teacher's school email address." Provide students with the teacher's email address. Make sure students use and enter the correct email address.
12. The bottom of the last page directs students to learn more about One Health using the links provided as Online Resources.
13. Teachers are encouraged to provide feedback using the **LSLC Virtual Field Trip Teacher Evaluation** form:

    Teacher evaluation form: https://redcap.link/2022-LSLC-VFT-Teacher_Feedback

Suggested Online Resources:

*Links to additional resources are added after some parts of the virtual field trip. You can also use these resources for additional asynchronous time for information discovery and reflection on concepts. Below is a full list of the **Suggested Resources:***

- This lesson is based on an actual outbreak of West Nile Virus in New York City.
    - **The Outbreak of West Nile Virus Infection in the New York City Area in 1999**
      https://www.nejm.org/doi/full/10.1056/NEJM200106143442401
    - **An outbreak of West Nile virus in a New York City captive wildlife population**
      https://www.ncbi.nlm.nih.gov/pubmed/12363067
    - **Encephalitis Society – Patient story videos.**
      https://www.encephalitis.info/what-is-encephalitis.

- **Centers for Disease Control and Prevention (CDC) - One Health**
  https://www.cdc.gov/onehealth/index.html

- **Centers for Disease Control and Prevention (CDC) - West Nile Virus**
  https://www.cdc.gov/westnile/index.html

- **Centers for Disease Control and Prevention (CDC) – Mosquito Life Cycle**
  https://www.cdc.gov/westnile/resources/pdfs/FS_MosquitoLifeCycle-508.pdf

- **Centers for Disease Control and Prevention (CDC) – Mosquito Control**
  https://www.cdc.gov/westnile/vectorcontrol/index.html

- **CDC/ArboNet: Map of West Nile distribution for humans, mosquitoes, birds, sentinel animals, and veterinary cases**
  https://wwwn.cdc.gov/arbonet/Maps/ADB_Diseases_Map/index.html

- **One Health: A Compelling Convergence**
  https://www.onehealthcommission.org/documents/filelibrary/resources/PerspectiveOne_HealthA_Convergence_E965B2367A94E.pdf

- **American Psychological Association- Team Science**
  https://www.apa.org/science/about/psa/2013/04/team-science.

Scan the QR code with your smartphone or tablet camera app to link to a file with all the One Health websites.

Known RNA Sequences for Four Viruses Carried by Mosquitoes

Saint Louis Encephalitis Virus

AACAGCGAUG AAACACCUUC UGAGUUUUAA GAAAGAACUA GGGACCUUGA CCAGUGCUAU CAAUCGGCGG

Dengue Virus

AUGCCCAGUG CUGUCGGCCG GUAAUGAUCC AGAAGACAUC GACUGUUGGU GCACAAAGUC AGCAGUCUAC

West Nile Virus

UGACAAACUU AGUAGUGUUU GUGAGGAUUA ACAACAAUUA ACACAGUGCG AGCUGUUUCU UAGCACGAAG

Yellow Fever Virus

AGUUGUGUUU GUCGUGCUGU UGCUCUUGGU GGCUCCAGC UACAGCUUCA ACUGCCUUGG AAUGAGCAAC

NGSS Correlation:

Working Towards Performance Expectations

MS-LS2-2. Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems. [Clarification Statement: Emphasis is on predicting consistent patterns of interactions in different ecosystems in terms of the relationships among and between organisms and abiotic components of ecosystems. Examples of types of interactions could include competitive, predatory, and mutually beneficial.]

HS-LS2-6. Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem. [Clarification Statement: Examples of changes in ecosystem conditions could include modest biological or physical changes, such as moderate hunting or a seasonal flood; and extreme changes, such as volcanic eruption or sea level rise.]

Science and Engineering Practices	**Disciplinary Core Ideas**	**Cross Cutting Concepts**
• Construct an explanation that includes qualitative or quantitative relationships between variables that predict phenomena.	• Predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared. • A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability.	• Patterns can be used to identify cause and effect relationships. • Much of science deals with constructing explanations of how things change and how they remain stable. (Stability and Change) • Cause and effect relationships may be used to predict phenomena in natural or designed systems.

Mysterious Case of Brain Illness
ANSWER KEYS

Part 1: What is causing an outbreak of encephalitis?

Eight patients were admitted to intensive care units at hospitals located in the same area of New York City. These patients experienced fever, seizures, confusion, muscle pain, and muscle weakness. Based on their symptoms, doctors suspected that the patients have encephalitis. Encephalitis is an inflammation (swelling) of the brain, often caused by a viral infection. It can lead to death or permanent disabilities.

Interviews with the patients and their families revealed only two things that the eight patients had in common. All of them lived in the same 2 X 2-mile area. All of them were involved in outdoor activities around their homes. These activities took place in the evenings when mosquitoes would be active and biting.

Environmental health investigators examined the patients' yards and neighborhoods. They found large populations of adult and developing mosquitoes. The environmental health investigators also observed many things filled with standing (stagnant) water such as buckets, trash cans, old tires, clogged gutters, and toys. Mosquitoes can breed (lay their eggs and develop) in even small amounts of standing water.

The environmental investigations led doctors to suspect that the outbreak of encephalitis cases might be caused by viruses carried by mosquitoes. People could become infected with these viruses when they are bitten by a mosquito that carries the virus.

1. How did the work of environmental health investigators help the doctors understand what might be causing the encephalitis outbreak?

   Environmental investigations suggested that the encephalitis outbreak might be caused by viruses carried by mosquitoes.

Researchers wanted to conduct tests to identify what type of virus was causing the encephalitis. When a person is infected with a virus, their immune system will produce antibodies. These antibodies prevent virus diseases by attaching to antigens (proteins) on the surface of viruses.

You will conduct tests to determine what antibodies are present in blood plasma (the liquid part of blood) from Patient 1. This will help you determine if Patient 1 has been infected with an encephalitis-causing virus known to be carried by mosquitoes in the United States.

Use the materials and instructions in the **Virus Test Kit** simulation to test blood plasma from Patient 1 to determine what type of virus is causing his encephalitis. The circles on the **Virus Test Strip** have been coated with antigens from viruses known to be carried by mosquitoes found in the United States.

2. What is the name of the virus that is causing Patient 1's encephalitis? Support your answer with evidence from the antibody tests.

Patient 1's encephalitis is caused by the Saint Louis Encephalitis Virus. I know this because sample E turned pink when exposed to the patients' blood

Tests conducted on plasma from the other seven patients showed that their immune systems produced antibodies against the same type of virus as Patient 1. Testing of patients from surrounding towns and cities revealed that the same antibodies were present in the plasma of approximately 50 additional patients.

3. Explain how this virus spreads to affect the additional patients.

The virus spreads through mosquitoes biting humans. OR It may spread when one mosquito bites an infected person and then bites and infects someone else.

Part 2: Is there a link between bird deaths and the encephalitis outbreak?

For several weeks before and during the encephalitis outbreak in humans, veterinarians at a nearby zoo noticed a large die-off of birds. Captive birds, such as flamingos, and native birds, such as crows, were dying. Veterinarians examined the dead birds and discovered that the birds had died from encephalitis.

The veterinarians wondered if there might be a link between the outbreaks of bird encephalitis and the outbreaks of human encephalitis. Could the bird deaths be caused by the Saint Louis Encephalitis virus? This seemed unlikely because the Saint Louis Encephalitis virus had never been found in birds.

The veterinarians conducted genetic tests on the viruses from the brains of several dead crows and zoo birds. To identify the viruses that killed the birds, they compared the genetic information from these viruses to the genetic information from other animal viruses known to cause encephalitis.

4. Why did the veterinarians conduct genetic tests on viruses from the brains of the dead birds?

   The veterinarians used the genetic tests to identify the viruses that infected the dead birds. OR They compared the genetic information in the viruses to the genetic information from other animal viruses that cause encephalitis.

5. The genetic information for the viruses that cause encephalitis is coded in a sequence of nucleotide bases (A, U, C, G) in RNA molecules. The sequence of letters below represents part of an RNA molecule from the virus that killed one of the birds.

   AGUAGUGUUU GUGAGGAUUA ACAACAAUUA

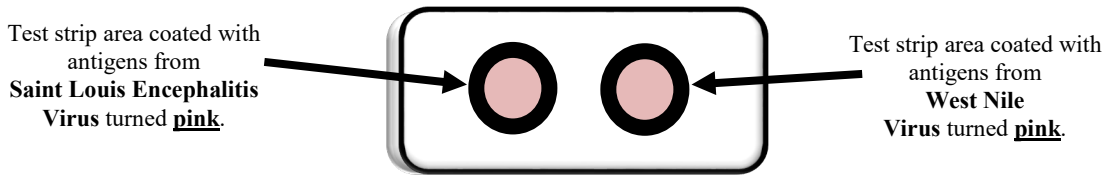
   - Compare this sequence of letters with the sequences of letters on the **Known RNA Sequences for Four Viruses Carried by Mosquitoes** sheet.

   - Which type of virus most likely caused the bird encephalitis? Support your answer with evidence from the genetic information.

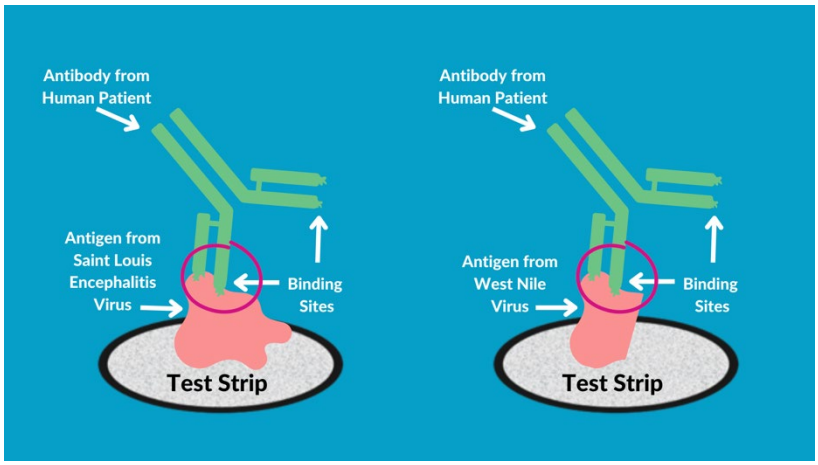
     The bird encephalitis was most likely caused by West Nile Virus. The sequence from the virus that killed the birds matches the sequence found in this West Nile Virus.

The veterinarians reported the results of the genetic tests on birds to the city Department of Health. Because the bird encephalitis and human encephalitis cases occurred at about the same time, scientists at the Department of Health wondered if the human encephalitis cases might be caused by West Nile virus instead of Saint Louis Encephalitis virus.

To test this, the scientists added blood plasma from one of the human patients with encephalitis to a test strip that had been coated with antigens from Saint Louis Encephalitis virus and antigens from West Nile virus. Both areas of the test strip turned pink, indicating that the patient's antibodies had attached to the antigens from both Saint Louis Encephalitis virus and West Nile virus.



Antibodies have specific binding sites and will only attach to parts of antigens that fit into their binding site.



6. Use the information in the diagram above to explain why the antibodies in Patient 1's blood plasma could attach to antigens from BOTH the Saint Louis Encephalitis virus and the West Nile virus.

The antibodies in the patient sample had binding sites that fit the shapes on BOTH antigens.

7. To determine whether Saint Louis Encephalitis virus or West Nile virus was causing the human encephalitis outbreak, scientists from the Health Department did genetic tests on the viruses that cause human encephalitis. The genetic information below represents part of an RNA molecule from a virus that caused the outbreak of human encephalitis.

GUGAGGAUUA ACAACAAUUA ACACAGUGCG

- Compare this genetic information (sequence of letters) with the **Known RNA Sequences for Four Viruses Carried by Mosquitoes**.

- Which type of virus caused the human encephalitis outbreak? Support your answer with evidence from the genetic information.

  West Nile Virus caused the human outbreak. The sequence of letters from the human sample matches the sequence of letters for West Nile Virus.

8. Explain how the work done by veterinarians was important in protecting human health.

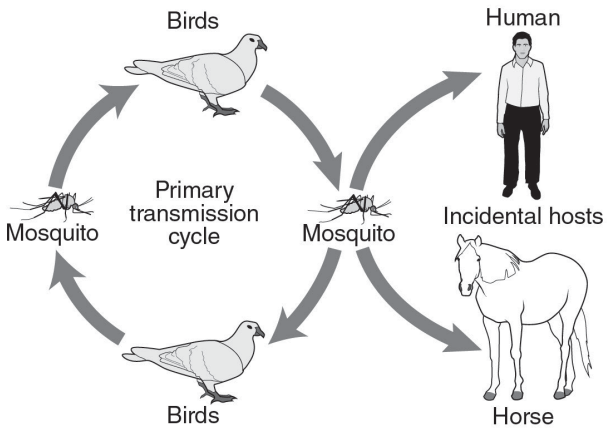
   The doctors wouldn't have known to test West Nile if it hadn't been for the veterinarians. OR The veterinarians identified the virus causing dead birds and suggested that it might be causing the human encephalitis outbreak.

Part 3: How is West Nile virus transmitted and spread?

Virus Transmission (from organism to organism)

West Nile virus primarily infects birds, but it can also infect bats, horses, cats, dogs, chipmunks, skunks, squirrels, domestic rabbits, alligators, and humans. West Nile viruses are kept in the environment because they are easily transmitted between birds (the natural hosts of the virus) and mosquitoes.

West Nile viruses are spread by the bite of an infected mosquito. The number of birds and mosquitoes infected with West Nile virus increases as mosquitoes pass the virus from bird to bird.



Transmission of West Nile Virus

Note: Mosquitoes usually do not become infected with the virus when they bite a human or horse. This is because the concentration of West Nile viruses in human and horse blood is too low to transmit the virus to mosquitoes.

Base your answers to questions 9 and 10 on the **Virus Transmission** illustration and the text above.

9. The transmission of West Nile virus is shown in the illustration above. Based on this illustration, put an "**X**" in front of the statements below that are correct.

__X__ Birds can become infected with West Nile virus when they are bitten by mosquitoes.

__X_ Humans and horses can become infected with West Nile virus when they are bitten by mosquitoes.

__X__ Mosquitoes can become infected with West Nile virus when they bite birds.

_____ Birds can transmit West Nile virus to other birds.

_____ Birds can transmit West Nile virus to humans.

_____ Mosquitoes can become infected with West Nile virus when they bite humans or horses.

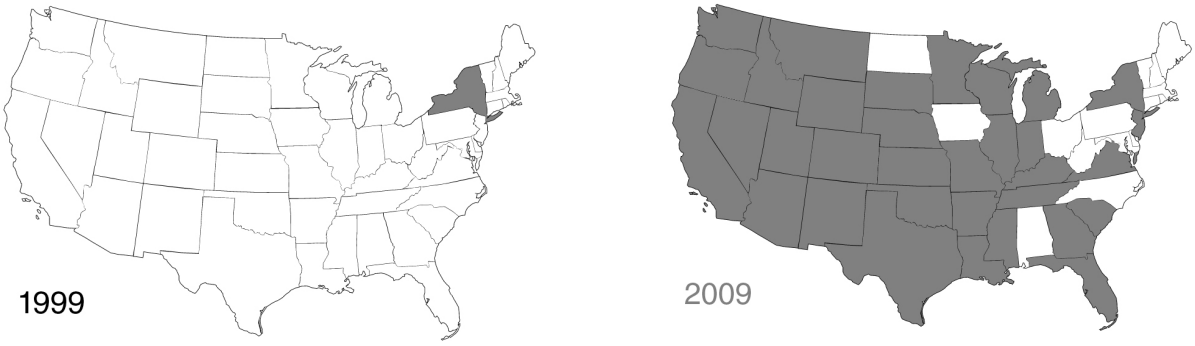
_____ West Nile virus can be transmitted by human-to-human contact.

10. Before 1999, the West Nile virus had never been found in the United States. It had only been found in Europe, the Middle East, and Africa. What two organisms most likely carried West Nile virus to the United States from Europe, the Middle East, or Africa?

Mosquitoes and birds

Virus Spread (from place to place)

Birds infected with West Nile Virus and mosquitoes that bit the infected birds have spread West Nile virus to humans and animals in other parts of the United States. The black areas on the continental United States maps below show cases of West Nile virus encephalitis in 1999, and 10 years later in 2009.



Modified from: https://www.cdc.gov/westnile/statsmaps/finalmapsdata/index.html

Base your answers to questions 11 and 12 on the **Virus Spread** illustration and the text above.

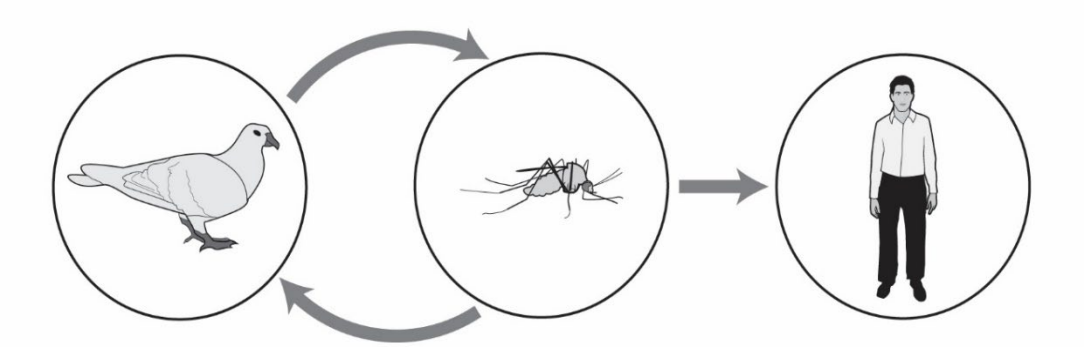
11. Explain how West Nile virus could spread so rapidly throughout the continental United States.

Birds and mosquitoes could have easily carried it from state to state. Birds migrate long distances. Mosquitoes only fly short distances. This means that birds are most likely responsible for the rapid spread.

12. Predict where in the continental United States you would expect to find West Nile virus in 2019.

I think it will spread to every state in the US. OR Students can qualify their predictions to indicate that all states may not have West Nile virus cases in a specific year.

Climate Change and West Nile Virus



Natural Host
Birds

Warmer winters, a longer frost-free season, and earlier spring arrival may change the migration patterns and survival of birds that are the natural hosts of the West Nile Virus.

Insect Vector Host
Mosquitoes

Rising temperature, changing precipitation patterns, and extreme weather events are likely to increase aquatic habitats for mosquito breeding and increase mosquito and viral reproduction rates.

Incidental Host
Humans

Humans are not central to the West Nile Virus transmission cycle, but they can suffer serious health consequences if infected. Changing weather patterns will likely impact human behavior and exposure to mosquitoes that carry West Nile virus.

Base your answers to questions 13 through 14 on the **Climate Change and West Nile Virus** illustration and the text above.

13. How would an increase in bird populations affect the number of mosquitoes that carry the West Nile virus?

    As the bird population increases, the number of moquitoes that carry the virus will most likely increase.

14. How would an increase in mosquito populations affect the number of birds infected with West Nile virus?

    As the mosquito population increases, the bird population infected will most likely increase.

15. How would an increase in mosquito populations affect the number of humans infected with West Nile virus?

    As the mosquito population increases, the number of humans infected will also increase.

16. What environmental factors might lead to increased bird populations in an area?

Warmer winters, longer frost free periods, and earlier springs may influence the migration and survival of birds.

17. What environmental factors might lead to increased mosquito populations in an area?

Increased temperature, increased rainfall, or severe weather events can increase mosquitoes in the area.

Climate change is a change in the average conditions — such as temperature and precipitation — in a region over a long period of time. NASA scientists have observed that the Earth's surface is warming and the distribution of precipitation is changing.

Modified from: https://climatekids.nasa.gov/climate-change-meaning/

18. Scientists claim that **climate change** is likely to cause an increase in the number of people infected with West Nile virus. Cite two pieces of evidence from the illustration and text on the previous page to support this claim.

Student answers may vary. Possible answers include, but are not limited to:

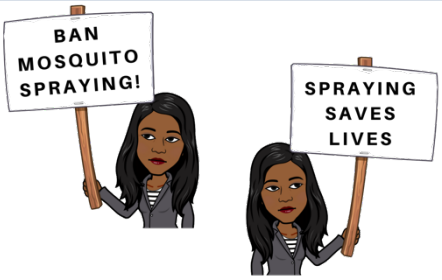
Climate change is causing increases in temperature around the world. This increased temperature will produce more mosquitoes that are vectors, and more birds which carry the disease.

Climate change will cause unusual weather patterns. This will alter the migration patterns of the birds and mosquitoes, causing the virus to infect more humans.

Part 4: Should insecticides be sprayed to prevent the spread of West Nile virus?

The State Health Department has announced plans to use planes to spray insecticides that kill mosquitoes.

Some residents oppose the plan to spray insecticides. Others support the planned spraying. A public meeting will be held to allow residents to express their support or opposition to the insecticide spraying.



19. Read the news article (below and on the next page) about a State Health Department's plan to spray insecticides to control the spread of West Nile virus. As you read:

- Underline information that someone could use to convince people that insecticides should be sprayed
- Circle or highlight information that someone could use to convince people that insecticides should not be sprayed

News Article: West Nile Virus Has Killed 3 in the State

An outbreak of encephalitis caused by West Nile virus has occurred in 13 counties. There have been 9 confirmed human cases of West Nile disease and 3 of these cases resulted in death. There have also been 27 cases among animals, including horses, deer, and dogs.

According to the state's public health veterinarian, "Aerial spraying is a tool we should use to protect human and animal health." The state plans to spray an organic insecticide to control populations of mosquitoes in 13 counties. Planes flying at 300 feet will spray an organic insecticide over 720,000 acres, at an estimated cost of between $1.5 million and $1.8 million. The insecticide is toxic to insects and it is commonly used to control mosquitoes, fleas, flies, moths, ants, and many other insect pests. Scientific tests have shown that the insecticide will not pose a health risk to humans, pets, or farm animals. Aerial spraying is not expected to affect surface water or drinking water.

Some community members are concerned about exposure to the insecticide spray. State officials suggest that people with asthma or chemical sensitivities remain indoors, close windows and doors, shut off fans and air conditioners, and wash any garden produce before eating it.

An ecologist with the State Department of Natural Resources is concerned about the effects of the insecticide on the environment. The insecticide being used is a "broad spectrum insecticide that has the potential to affect any insect it comes in contact with, including

beneficial species (bees and other pollinators) and threatened species (butterflies and moths)."

Many beekeepers and farmers are worried that the spraying of insecticides will contaminate crops and kill bees that pollinate crops. However, one beekeeper stated, "While the death of bees will affect my source of income, I really don't want to see one of my friends become sick with this virus."

Even with the planned spraying, state health officials say the risk for contracting West Nile disease from mosquitoes in affected areas will continue until after the season's first "hard frost." State health officials encourage residents in the affected counties to:

- Empty water from mosquito-breeding sites around the home such as buckets, unused pools, old tires, clogged gutters, or similar places with standing water where mosquitoes may lay eggs.
- Avoid being outdoors from dusk to dawn when mosquitoes that carry the West Nile virus are most active.
- Wear long-sleeved shirts and pants.
- Apply insect repellents that contain the active ingredient DEET, or another U.S. Environmental Protection Agency-approved product to exposed skin or clothing.
- Maintain window and door screening to help keep mosquitoes outside.
- More information about mosquito control is available at https://www.cdc.gov/westnile/vectorcontrol/integrated_mosquito_management.html

Modified from https://www.northjersey.com/story/news/nation/2019/09/27/eastern-equine-encephalitis-michigan-aerial-insecticides/3793737002/

20. Based on the information in the article, list the two most important things someone might say to convince people that insecticides should be sprayed to kill mosquitoes and prevent West Nile disease.

Student answers will vary. Possible answers might include, but are not limited to: Spraying will kill mosquitoes and reduce the risks for people or animals getting West Nile infections. OR The insecticide will not pose a health risk to humans, pets, or farm animals.

21. Based on the information in the article, list the two most important things someone might say to convince people that insecticides should not be sprayed to kill mosquitoes and prevent West Nile disease.

Student answers will vary. Possible answers might include but are not limited to: Spraying may harm some humans. OR Spraying will kill beneficial insects.

22. Is the article biased - prejudiced in favor of spraying or against spraying? Support your answer.

Student answers will vary. Possible answers may include. The article is biased because there is specific information to support spraying. OR The article is not biased because both points of view are included.

23. The article does not include all the information that might be needed to make an informed decision about the planned insecticide spraying. List at least two kinds of additional information that might help people to make an informed decision about whether to spray, or not spray, to control mosquito populations.

Student answers may vary. Possible answers may include, but are not limited to: Is there any other way to control the mosquito populations? Is there scientific research on this insecticide? How effective is the insecticide at killing mosquitoes and other insects? Did spraying in other communities actually decrease the number of people and animals infected with West Nile virus?

24. A trade-off is a compromise where people give up one thing in order to get something else that they want. The State Health Department insists that spraying is the best way to reduce the spread of the West Nile virus. Concerned citizens are against spraying because they are concerned that spraying will harm humans, animals, and the environment. Suggest a possible tradeoff (compromise) that both groups could accept. Be prepared to explain your tradeoff to the class.

Student answers may vary. Possible answers may include but are not limited to: Use money saved from not spraying to provide a community program to get rid of places where mosquitoes reproduce. Allow communities in a county to vote on whether they want spraying or not. Only spray in cities where there are more people and fewer animals/insects that will be affected.

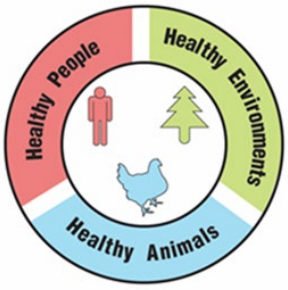
25. Do you support the spraying of insecticides to kill mosquitoes and prevent the spread of West Nile virus? Explain why or why not.

Student answers may vary.

Part 5: One Health and the West Nile virus

One Health

A university is suggesting that the local government take a One Health approach to solving complex local problems, such as West Nile virus. A One Health approach uses the idea that complex problems often involve the health of people, animals, and the environment. Therefore, solutions to One Health problems must be designed to protect the health of people, animals, and the environment.



26. Use the information in the text box above to explain what must be involved in a complex problem for it to be considered a One Health problem.

It must involve humans, animals, and the environment.

To support adoption of a One Health approach, the university officials want to create a series of One Health digital slides to share with community members. Your team has been hired to create the first slide for this presentation. They want you to use West Nile virus as an example of a One Health problem. The slide you produce should answer the question, "**Why are West Nile viruses a One Health problem?"**

Community members often get most of their information from this first slide – they tend to lose interest once in-depth discussion of the issue begins. Therefore, that first slide needs to give information in a way that people will remember. Using examples and pictures will help people understand and remember what the One Health approach involves.

27. Use the information in the text box and what you learned about West Nile viruses to develop your slide. The following template may help you organize your digital slide:

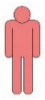
Why are West Nile viruses a One Health problem?	
Credit given for providing 1-2 sentences that respond /answer the question	***Credit given for providing a picture with brief caption***
Credit given for providing a picture with brief caption	***Credit given for providing a picture with brief caption***

Optional Extension Activity and Questions:

1. Ask students to identify their own One Health Problem. They can use the table provided.

One Health Problem		
Environment	**Animals**	**People**
		
Credit given for responses that include "environment." Answers will vary and be specific to each student.	***Credit given for responses that include "animals." Answers will vary and be specific to each student.***	***Credit given for responses that include "people." Answers will vary and be specific to each student.***

2. Ask students to identify their own One Health Solutions. Have students complete and compare the **Possible One Health Solutions** in the chart below. Brainstorm ideas for actions that could be taken to "solve" parts of problem that you described in question 4. Be sure to include actions that would improve the health of humans, animals, and the environment.

One Health Solutions		
Environment	**Animals**	**People**
		
Credit given for responding. Answers will vary and be specific to each student.	***Credit given for responding. Answers will vary and be specific to each student.***	***Credit given for responding. Answers will vary and be specific to each student.***

3. Which One Health solution would be easiest for <u>you</u> to implement? Explain why you chose that solution.

   Credit given for responding. Answers will vary and be specific to each student.

4. Which One Health solution would be easiest for <u>local communities</u> to implement? Explain why you chose that solution.

   Credit given for responding. Answers will vary and be specific to each student.

5. Which One Health solution would have <u>the greatest impact</u> on solving the One Health problem caused by the invasion of ticks? Explain why you chose that solution.

   Credit given for responding. Answers will vary and be specific to each student.