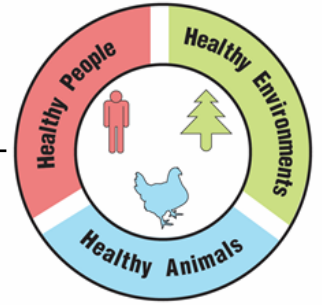


# Mysterious Case of Brain Illness



## 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. What did the environmental health investigators learn that helped the doctors understand what might be causing the encephalitis outbreak?

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.

2. Use the materials and instructions in the **Virus Test Kit** to test blood plasma from Patient 1 to determine what type of virus is causing his encephalitis. The circles on the **Virus Test Sheet** have been coated with antigens from viruses known to be carried by mosquitoes found in the United States.
3. What is the name of the virus that is causing Patient 1's encephalitis? Support your answer with evidence from the antibody tests.

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.

4. Explain how this virus spread to affect the additional patients.

## 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.

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

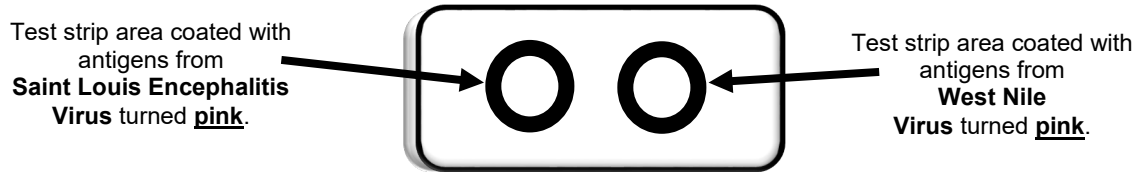
6. The genetic information for the viruses that cause encephalitis is coded in a sequence of nucleotide bases (A, U, C, G) in RNA molecules. The sequence of letters below represents part of an RNA molecule from the virus that killed one of the birds.

AGUAGUGUUUGUGAGGAUUAACAACAAUUA

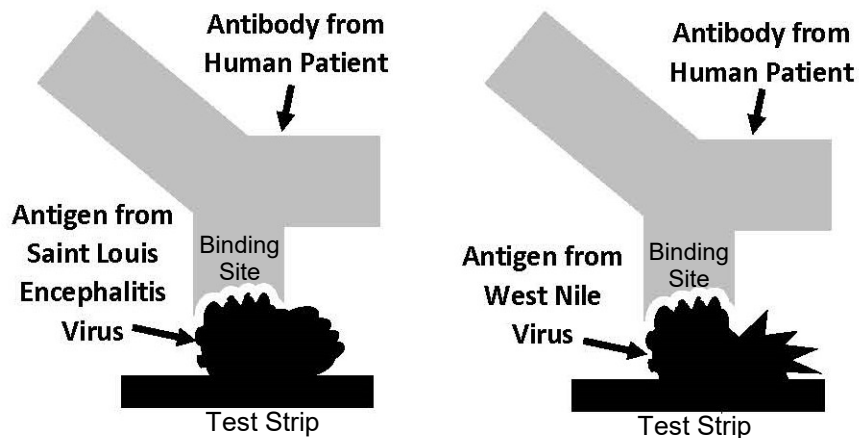
- Compare this sequence of letters above with the sequences of letters on the **Known RNA Sequences for Four Viruses Carried by Mosquitoes** sheet.
- Which type of virus most likely caused the bird encephalitis? Support your answer with evidence from the genetic information.

The 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.



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



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.

8. 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.

GUGAGGAUUAACAACAAUUAACACAGUGCG

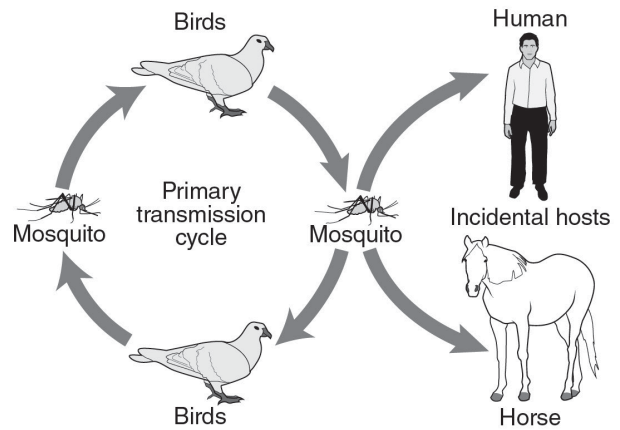
- Compare this genetic information (sequence of letters) with the **Known RNA Sequences for Four Viruses Carried by Mosquitoes**.
  - Which type of virus caused the human encephalitis outbreak? Support your answer with evidence from the genetic information.
9. Explain how the work done by veterinarians was important in protecting human health.

### 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**

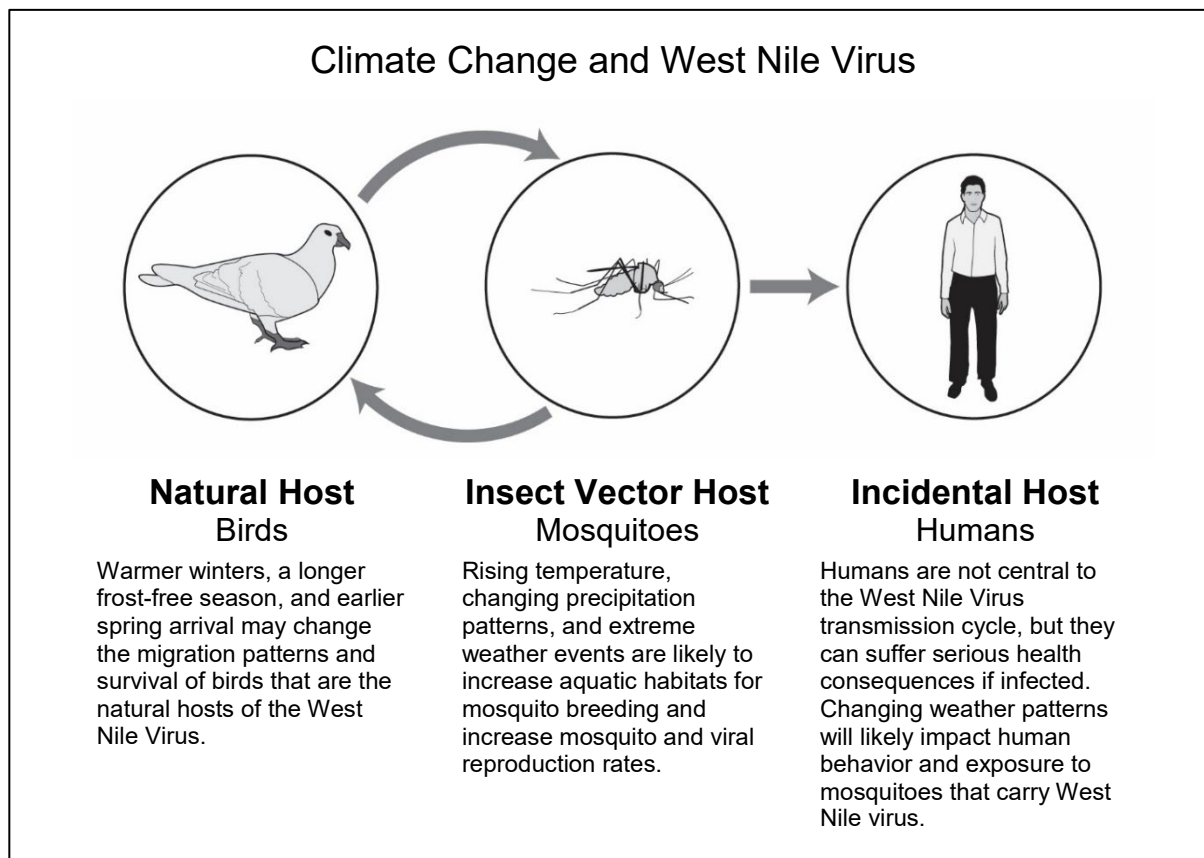
*Note: Mosquitoes usually do not become infected with the virus when they bite a human or horse. This is because the concentration of West Nile viruses in human and horse blood is too low to transmit the virus to mosquitoes.*

Base your answers to questions 1 and 2 on the **Virus Transmission** illustration and the text above.

1. The transmission of West Nile virus is shown in the illustration above. Based on the illustration, put an “X” in front of the statements below that are correct.

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





Base your answers to questions 5 through 10 on the **Climate Change and West Nile Virus** illustration and the text above.

5. How would an increase in bird populations affect the number of mosquitoes that carry the West Nile virus?
  
6. How would an increase in mosquito populations affect the number of birds infected with West Nile virus?
  
7. How would an increase in mosquito populations affect the number of humans infected with West Nile virus?



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

9. What environmental factors might lead to increased mosquito populations in an 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/>

10. 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 **Climate Change and West Nile Virus** illustration and text on the previous page to support this claim.

#### 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.

Ban  
Mosquito  
Spraying!

Spraying  
Saves  
Lives

1. 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](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/>

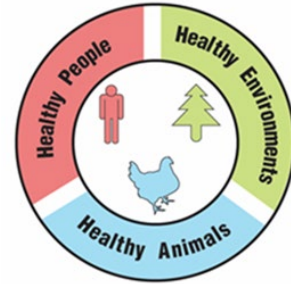
2. Based on the information in the news article, list the two most important things someone might say to convince people that insecticides should be sprayed to kill mosquitoes and prevent West Nile disease.
3. Based on the information in the news article, list the two most important things someone might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

4. Is the news article biased - prejudiced in favor of spraying or against spraying? Support your answer.
  
5. The news article does not include all of the information that people might need 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.
  
6. 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.
  
7. Do you support the spraying of insecticides to kill mosquitoes and prevent the spread of West Nile virus? Explain why or why not.

## 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 viruses. 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.



1. 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.

To support adoption of a One Health approach, the university officials want to create a series of slides to provide examples of One Health problems in the community. Your team has been hired to create a slide to answer the question, **“Why are West Nile viruses a One Health problem?”**

Remember how the CDC video used images with captions to help people understand what One Health problems and solutions involve. Using pictures and captions will help people understand and remember what the One Health approach involves.

2. Use the information in the text box above and what you learned about West Nile viruses to develop your slide. Use the following template to organize your slide:

<b>Why are West Nile viruses a One Health problem?</b>		
Picture and a caption to explain how <b>animals</b> are involved in the problem	Picture and a caption to explain how <b>humans</b> are involved in the problem	Picture and a caption to explain how <b>the environment</b> is involved in the problem