Operation Outbreak
Hamlet's Story

CDC Science Ambassador

Activity details

Age or grade level
This activity is intended for middle and high school teachers to teach public health using the *The Junior Disease Detectives, Operation: Outbreak* graphic novel in their classrooms.

Learning objectives
At the end of this activity, students should be able to

- Define zoonotic influenza virus.
- Explain how some influenza viruses in animals have the potential to cause disease in humans, and how some influenza viruses in humans can infect animals.
- Define *variant virus* and explain how it is a specific kind of zoonotic influenza virus in humans; also explain risk factors for variant virus infections in humans.
- Differentiate between direct and indirect transmission and explain the different modes of transmission through which influenza viruses can spread between hosts, such as humans and animals.
- Define *novel influenza virus* and explain how zoonotic and novel influenza A virus infections on rare occasions can cause pandemics among humans.

Problem-based skill
Identifying trends

National standards
HS-EPHS1-1: Describe how epidemiologic thinking is used to provide an evidence-based explanation concerning causes and correlations of health and disease.
https://www.cdc.gov/careerpaths/k12teacherroadmap/pdfs/ephs-competencies.pdf

NGSS Science & Engineering Practice: Developing and using models; Crosscutting Concept: Systems and system models
http://www.nextgenscience.org/get-to-know

Activity time
45 minutes

Handouts
- Chains of Infection: Story Map Outlines
- Story Map

Materials
- The Junior Disease Detectives, Operation: Outbreak graphic novel (https://www.cdc.gov/flu/graphicnovel)
- Internet access

Introduction

When an outbreak occurs, disease detectives try to identify what the infectious agent is, how it is being transmitted, and who or what is transmitting it by mapping the **chain of infection.** The chain of infection provides a detailed account of how an infectious agent interacts with its host(s) and environment. More specifically, it shows the sequence of events. It starts when the infectious agent leaves its **reservoir host** — the natural habitat (animal or environment). This is where the infectious agent normally lives, grows, and multiplies. Note: reservoir species may not appear ill, and this is true of some avian influenza (bird flu) viruses in wild waterfowl. Likewise, pigs infected with influenza do not always display signs of illness. So animals that appear healthy can still carry and spread disease. The infectious agent leaves the reservoir host through a **portal of exit**. It is then transported by some **mode of transmission** and can enter a susceptible host through an appropriate **portal of entry**.

Note: different schools of thought exist regarding modes of transmission. This document teaches modes of transmission based on CDC's existing scientific literature on influenza transmission as well as "Principles of

Epidemiology in Public Health Practice". See the resources section for links to relevant information.

An infectious agent may be transmitted from its natural reservoir (host or environment) to a susceptible host in different ways. The mode of transmission can be direct or indirect.

Direct transmission occurs when the infectious agent is transferred from its reservoir to a susceptible host without an intermediate step. This can occur by **direct contact** (e.g., physical contact between an infected host and a susceptible host) or **droplet spread** (i.e., droplets containing an infectious agent that are produced through coughing, sneezing, talking, or possibly even breathing). For example, when a person coughs or sneezes, droplets are produced that range in size from large to very small. Very small droplets are characterized as "aerosols." Experts believe that most influenza virus transmission occurs via large droplets and that these droplets travel generally short distances (i.e., up to about 6 feet) from an infected host. Less is known about the ability of influenza viruses to spread via aerosols, which is a topic that scientists continue to research. Large droplets tend to infect the upper respiratory tract (e.g., the nose and nasal passages), whereas aerosols have the potential to enter the lower respiratory tract (e.g., the trachea, bronchi, and lungs).

Indirect transmission occurs when an infectious agent is transferred from its reservoir to an inanimate object or surface (i.e., **fomite**) and then from that inanimate object or fomite to a susceptible host. For example, if an influenza-infected pig eats out of a food trough shared by other pigs, it is possible that respiratory secretions from the infected pig could contaminate the food trough with influenza virus. Subsequently, other uninfected pigs who eat out of that same food trough could become infected with influenza virus through indirect transmission.

Switching to a human example of indirect transmission: if an influenza-infected person sneezes or coughs into his or her hands, and then touches a doorknob, the doorknob can become contaminated with influenza virus. Soon after, if another (susceptible) person touches that same doorknob while influenza virus is still present and viable and then touches his or her eyes, nose, or mouth, he or she could become indirectly infected with influenza. Experts currently believe that the influenza virus can "live" on some surfaces for up to 48 hours.

Vector-borne transmission is another form of indirect transmission involving vectors, such as mosquitoes, fleas, or ticks. Malaria and Lyme disease are examples of vector-borne diseases. Influenza is not spread through vectors.

In some outbreaks, the infectious agent can be transmitted from animals to human hosts, causing human disease. Similarly, infectious agents can be transmitted from humans to animal hosts, causing animal disease. The term ***zoonotic disease* or *zoonosis*** is used to describe these infections spread between animals and humans. For example, certain influenza A viruses that normally circulate among birds or among pigs can be transmitted to human hosts, causing human disease. When an influenza A virus that normally circulates among birds infects a human, it is called an avian influenza A virus infection. When an influenza A virus that normally circulates among pigs infects a human, it is called a variant influenza A virus infection. Both are considered novel influenza A virus infections because a person is infected with an influenza A virus that is different from the seasonal influenza A viruses that normally circulate in humans.

Although animals can occasionally transmit influenza viruses to people, people also can transmit human influenza viruses to animals. Pigs are often called mixing vessels because they are susceptible to influenza viruses from multiple animal species, including humans. It is possible for two or more influenza A viruses from different species to infect a pig at the same time. When this happens, it is possible for the genes of these different influenza viruses to mix and create a new influenza A virus. This act of multiple viruses infecting and mixing within a single host is called **reassortment.**

Reassortment is one way that **antigenic shift** can occur. This abrupt, major change in the molecular make-up of the influenza virus can result in an influenza A virus that is **novel** or different from influenza A viruses currently circulating in people. People generally do not have any pre-existing antibodies to protect against novel influenza A viruses. If such novel influenza A viruses gain the ability to spread efficiently between people (i.e., easily transmit from person to person and forming long chains of transmission), it could result in a pandemic (i.e., the global spread of a new influenza virus). In the case of the last four flu pandemics, the pandemic influenza A viruses had at least some genes derived from influenza A viruses that normally circulate among birds or pigs in addition to genes of influenza viruses that normally circulate among people.

In this activity, students will explore chains of infection among birds, pigs, or humans, as well as among these three populations. Students will learn how disease infections among other species can have a dramatic impact on the health and well-being of people in their own community.

Did you know?

Health experts believe the 2009 H1N1 influenza pandemic was caused by gene reassortments between influenza A viruses from North American pigs, Eurasian pigs (i.e., pigs originally from Europe or Asia), birds and humans, making it a quadruple reassortant virus.

Resources

Principles of Epidemiology in Public Health Practice: Lesson 1, Section 10: Chain of Infection (https://www.cdc.gov/csels/dsepd/ss1978/lesson1/section10.html)

How the Flu Virus Can Change: "Drift" and "Shift" (https://www.cdc.gov/flu/about/viruses/change.htm)

Transmission of Influenza Viruses from Animals to People (https://www.cdc.gov/flu/about/viruses/transmission.htm)

Information on Avian Influenza-Bird Flu Basics (https://www.cdc.gov/flu/avianflu/bird-flu-basics.htm)

Graphic - Flu Can Spread Between Pigs and People (https://www.cdc.gov/flu/pdf/swineflu/transmission-between-pigs-people.pdf)

Graphic - How Infected Backyard Poultry Could Spread Bird Flu to People (https://www.cdc.gov/flu/pdf/avianflu/avian-flu-transmission.pdf)

Information on Swine Influenza/Variant Influenza Virus (https://www.cdc.gov/flu/swineflu/)

CDC One Health website (https://www.cdc.gov/onehealth)

USDA One Health website (https://www.usda.gov/topics/animals/one-health)

Activity instructions

Explain

In ecology, we study the interactions that organisms have with each other, other organisms, and their environment. Similarly, in epidemiology, we study the ecology of infectious agents (for example, viruses, bacteria), reservoirs (the natural habitat in which the infectious agent normally lives, grows, and multiplies), and susceptible hosts (organisms that can become infected). When the infectious agent spreads from animals to humans, these zoonotic infections illustrate how events that take place in other animals may ultimately affect human health in our communities. When the infectious agent crosses between humans and animals, it can also affect livelihoods and economies. This is why a **One Health** approach is used to investigate outbreaks of zoonotic diseases. A One Health approach requires human, animal

and environmental health professionals to work together at the local, state, federal, and global levels to improve the health of people, animals and their shared environment.

Instruct

1. For homework, assign students to read *The Junior Disease Detectives, Operation: Outbreak* graphic novel.

2. Divide students into five groups. Assign each group to create a chain-of-infection story map outline. Have students research the virus associated with their story map outline by using the CDC resources provided below each story map outline.

3. Review the outline for each group. Then, have each group design a story map by using their outline. A framework for a basic story map is provided; however, students may use a variety of tools, such as stop motion videos, infographics, and time-lapse videos.

4. Have each group present their story map to the class highlighting the chain of infection.

5. Have the class discuss the story maps in sequence from birds to humans. Encourage self-discovery that the antigenic shifts that can cause these events can take years to occur and can happen continents apart.

Discuss

1. How might Hamlet have been infected with an influenza A virus?

2. Identify the story maps that gave rise to variant influenza virus infections. Why are these variant influenza infections of concern to public health officials?

Information

Authors

Activities were developed as a collaboration between the CDC Science Ambassador Fellowship program in CDC's Center for Surveillance, Epidemiology, and Laboratory Services; science, technology, engineering, and mathematics (STEM) teachers from across the country who participated in the 2017 CDC Science Ambassador Fellowship; CDC's National Center for Immunization and Respiratory Diseases; and CDC's National Center for Emerging and Zoonotic Infectious Diseases.

CDC's Center for Surveillance, Epidemiology, and Laboratory Services
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CDC Science Ambassador Fellows
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CDC's National Center for Immunization and Respiratory Diseases
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CDC's National Center for Emerging and Zoonotic Infectious Diseases
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Disclaimer

Citation

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Chain of Infection: Story Map Outlines

Name: _____ Date: _____

Directions: Use the CDC resources provided below each story map outline to identify how influenza A viruses circulate among animal populations, such as within bird (avian), pig (swine), and human populations, and how certain viruses that circulate among one animal population can occasionally transmit to another animal population. Then, complete each story map outline by creating a story about the virus's **chain of infection** within or among an animal population provided in the story map outline title (e.g., Bird-Bird-Bird). Remember, the chain of infection is the process that begins when the virus leaves its reservoir or host through a portal of exit (e.g., mouth or saliva, or nose or mucous membrane) and conveyed by some mode of transmission (e.g., direct contact or touching, contaminated surfaces or fomite transmission, or viruses in the air, droplet, or airborne), and then enters through an appropriate portal of entry (e.g., eyes, nose, or mouth) to infect a susceptible host.

In the case of influenza A virus, the most common ways influenza can spread between pigs or birds and humans, include:

Direct Transmission

- Droplet spread (e.g., droplets containing virus produced by coughing or barking, sneezing, or talking that travel through the air short distances to a susceptible host)
- Direct contact (e.g., touching the infected host, including nasal or oral and sometimes fecal secretions and then touching one's own eyes, nose, or mouth; and kissing)

Indirect Transmission

- Fomites or contaminated surfaces (e.g., touching a contaminated inanimate object or surface such as food container, water feeder and then touching one's own eyes, nose, or mouth)

Set the stage

1. Select an **initial setting** in which your story will occur (e.g., fair, farm, city, wildlife park, or summer camp). Describe the setting in detail (e.g., a farm in Michigan with a large pond).
2. Identify the **initial reservoir** — the habitat in which an infectious agent normally lives, grows, and multiplies (e.g., bird, pig, human, or environment) — for the virus based on the title of the story map (e.g., **Bird**-Bird-Bird). Describe the reservoir in detail (e.g., a domestic duck living in the pond).

Create a chain-of-infection

3. Select the first host — **host A** (i.e., Bird-**Bird**-Bird). Describe the host in detail (e.g., an award-winning domestic Silkie chicken that was recently purchased and whose coop is located near the pond on the farm).
4. Identify a **method of transmission** to infect the **host A**. Describe the method of transmission in detail (e.g., the domestic duck living in the pond waddles up to the coop about 2 feet from the Silkie chicken and shakes its head releasing influenza virus into the air.) Then describe how host A becomes infected (e.g., the virus enters through the eyes, nose, or mouth [beak] of another chicken in the coop).
5. Identify the second host — **host B** (i.e., Bird-Bird-**Bird**). Then, identify a method of transmission infect **host B** (e.g., the infected Silkie chicken defecates on the ground, causing the ground to become contaminated with feces containing influenza virus. Next, the infected Silkie chicken flaps its wings and scratches the ground with its talons, which kicks up small particles containing influenza virus into the air. The virus then enters through the eyes, nose, or mouth of nearby Sebright chicken.)

Story Map Outline: Bird-Bird-Bird

Virus	**Avian influenza A (H7N9) virus**
Initial Setting	
Initial Reservoir	
Method of Transmission A	
Host A	
Method of Transmission B	
Host B	

CDC Resources: https://www.cdc.gov/flu/about/viruses/transmission.htm
https://www.cdc.gov/flu/avianflu/avian-in-birds.htm
https://www.cdc.gov/flu/avianflu/h7n9-virus.htm

Story Map Outline: Bird-Bird-Pig or Human

Virus	**Avian influenza A (H5N1) virus**
Initial Setting	
Initial Reservoir	
Method of Transmission A	
Host A	
Method of Transmission B	
Host B	

CDC Resource: https://www.cdc.gov/flu/avianflu/avian-in-birds.htm
https://www.cdc.gov/flu/avianflu/avian-in-humans.htm

Story Map Outline: Pig-Pig-Pig

Virus	**Swine influenza A (H3N2) virus**
Initial Setting	
Initial Reservoir	
Method of Transmission A	
Host A	
Method of Transmission B	
Host B	

CDC Resource: https://www.cdc.gov/flu/swineflu/h3n2v-basics.htm

Story Map Outline: Pig-Human-Human

Virus	**Swine influenza A (H3N2) virus (in the pig)** **Variant influenza A (H3N2) virus (when it infects a human)**
Initial Setting	
Initial Reservoir	
Method of Transmission A	
Host A	
Method of Transmission B	
Host B	

CDC Resources: https://www.cdc.gov/flu/swineflu/h3n2v-basics.htm
https://www.cdc.gov/flu/pdf/swineflu/transmission-between-pigs-people.pdf

Story Map Outline: Human-Human-Human

Virus	**Human seasonal influenza A (H1N1) virus**
Initial Setting	
Initial Reservoir	
Method of Transmission A	
Host A	
Method of Transmission B	
Host B	

CDC Resource: https://www.cdc.gov/flu/about/disease/spread.htm

Story Map Outline: Human-Human-Pig

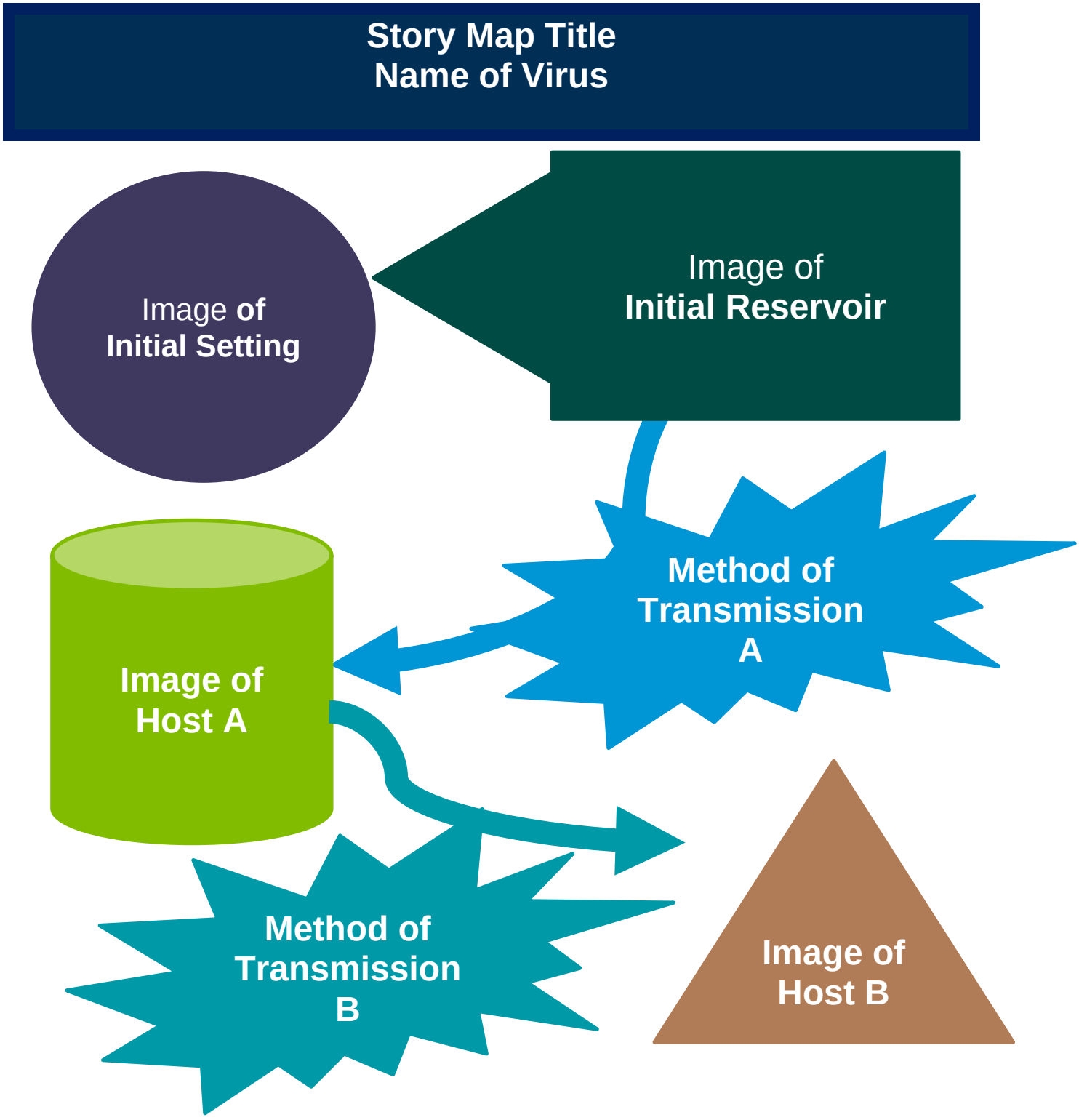
Virus	**Human seasonal influenza A (H3N2) virus**
Initial Setting	
Initial Reservoir	
Method of Transmission A	
Host A	
Method of Transmission B	
Host B	

CDC Resources: https://www.cdc.gov/flu/swineflu/people-raise-pigs-flu.htm
https://www.cdc.gov/flu/pdf/swineflu/transmission-between-pigs-people.pdf

Story Map

Name: _____ Date: _____

Directions: Create a story map by using the assigned story map outline. See below for a sample of how to create a story map.



Answer Key

Story maps will vary. Some examples of plausible scenarios are listed below.

Story Map Outline	Bird-Bird-Bird
Virus	Avian influenza A (H7N9) virus. Note: This example is specific to the North American lineage of influenza A (H7N9) virus.
Initial Setting	Habitat shared by wild and domestic birds (e.g., farm pond)
Initial Reservoir	Wild waterfowl (e.g., ducks or geese)
Method of Transmission A	**Direct Transmission** ▪ **Direct contact.** For example, an infected wild duck or goose had direct contact with an uninfected domesticated duck or chicken in a shared environment (e.g., a pond, lake, or river), which directly spread nasal secretions or feces that contained the virus between the birds. ▪ **Droplet spread.** For example, an infected wild duck or goose coughs or sneezes on an uninfected domesticated duck or chicken, which spread droplets that contained the virus between the birds and caused an infection. **Indirect Transmission** ▪ **Contaminated environments or contaminated surfaces (i.e., fomites).** For example, infected wild ducks or geese shed influenza virus in feces, which contaminated a surface that an uninfected domesticated duck or chicken also touches.
Host A	Domestic poultry, such as ducks and chickens.
Method of Transmission B	**Direct Transmission** ▪ **Direct contact.** For example, an infected domesticated duck or chicken had direct contact with other uninfected domesticated ducks, chickens or turkeys in a shared environment (e.g., a farm). This can occur through birds bumping into one another, preening (cleaning) one another, mating, or vying for food. ▪ **Droplet spread.** For example, an infected domesticated duck or chicken coughs or sneezes on an uninfected domesticated duck, chicken, or turkey. **Indirect Transmission** • **Contaminated environments or contaminated surfaces (i.e., fomites).** For example, feces from infected domesticated ducks or chickens have contaminated the ground shared by other poultry. Alternatively, infected poultry shared a feeding trough with other uninfected poultry that caused the trough to become contaminated with the virus).
Host B	Domestic poultry (i.e., chickens, ducks, and turkeys)

Story Map Outline	Bird-Bird-Pig or Human
Virus	Avian influenza A (H5N1) virus
Initial Setting	Live poultry market
Initial Reservoir	Infected chicken at market
Method of Transmission A	**Direct Transmission** • **Direct contact.** For example, an infected chicken is housed in an animal cage at the live poultry market with other uninfected chickens, which caused the virus to spread through direct bird-to-bird contact (this close contact likely transfers nasal secretions or feces that contained the virus from one bird to another)**.** • **Droplet spread.** For example, an infected chicken in a cage with other chickens may sneeze, cough, or defecate feces that contain the virus, which spread droplets containing virus to travel short distances through to air to nearby chickens and resulted in an infection. **Indirect Transmission** • **Contaminated environments or contaminated surfaces (i.e., fomites).** For example, feces or nasal secretions from an infected chicken can contaminate the cage and surrounding environment at a poultry market. Other chickens or pigs can then be exposed to these contaminated environment or surfaces and caused an infection.
Host A	Uninfected chicken
Method of Transmission B	**Direct Transmission** • Direct contact - Human example: A butcher preparing chicken meat for sale may directly touch infected chickens, (the contact likely transfers nasal secretions or feces that contained the virus to the butcher's hands. The butcher may then touch his or her own eyes nose, or mouth and resulted in infection. - Pig example: A live, infected chicken is purchased and brought to a farm to roam free with uninfected pigs, which allowed for direct contact between animals (direct contact can transfer nasal secretions or feces containing virus). • **Droplet spread.** For example, an infected chicken can cough, sneeze, or defecate feces that contain the virus, which caused droplets containing virus to travel through the air and enter the eyes, nose, or mouth of nearby people or pigs at the market. **Indirect Transmission** • **Contaminated environments or contaminated surfaces (i.e., fomites).** For example, feces or nasal secretions from an infected chicken can contaminate the cage and surrounding environment at a poultry market. A person, such as butcher, can then touch a contaminated surface and then touch his or her own eyes, nose, or mouth, which can transmit the virus. Similarly, pigs at the market may share the same contaminated environment with the infected chicken, which can result in exposure to the virus.
Host B	Human or pig

Story Map Outline	Pig-Pig-Pig
Virus	Swine influenza A (H3N2) virus
Initial Setting	Eddie's family pig farm
Initial Reservoir	Hamlet the Pig
Method of Transmission A	**Direct Transmission** • **Direct contact.** For example, Hamlet (who is infected) may directly contact another show pig at the fair, by bumping snouts while eating or other contact that resulted in transfer of the virus through nasal or oral secretions. • **Droplet spread.** For example, while infected at the fair, Hamlet could cough or bark or sneeze, which caused droplets containing virus to travel through the air and enter the eyes, nose, or mouth of nearby pigs at the fair (i.e., pig #2). **Indirect Transmission** • **Contaminated environments or contaminated surfaces (i.e., fomites).** For example, Hamlet, while infected, eats or drinks out of a food trough shared with other pigs, which resulted in contamination of the food or water troughs with nasal or oral secretions that contained the virus. Pig #2 then eats or drinks from the same contaminated surfaces, which resulted in an infection. Alternatively, Hamlet could bark or cough, or sneeze, which caused droplets that contain virus to contaminate the environment or surfaces shared with other pigs (i.e., pig #2).
Host A	Another pig #2 at the Thomas County Fair
Method of Transmission B	**Direct Transmission** • **Direct contact.** For example, the second infected pig (i.e., pig #2) may bump snouts or have some other form of direct contact with another uninfected pig at the fair. This could cause nasal or oral secretions that contain the virus to be passed from one pig to another. • **Droplet spread**. For example, infected pig #2 could sneeze, cough or bark, which caused droplets that contain virus to travel through the air to the eyes, nose, or mouth of nearby pigs and cause an infection. **Indirect Transmission** • **Contaminated environments or contaminated surfaces (i.e., fomites).** For example, infected pig #2 could cough or bark, or sneeze, which caused droplets that contained the virus to contaminate the environment or surfaces shared with other pigs (i.e., pig #3). Alternatively, infected pig #2 could eat or drink out of a food trough shared with other pigs that resulted in contamination of the food or water troughs with nasal or oral secretions that contain virus. Pig #3 could then become infected while eating or drinking from the same surfaces.
Host B	Another pig #3 at the Thomas County Fair

Story Map Outline	Pig-Human-Human
Virus	Swine influenza A (H3N2) virus (in a pig) and Variant influenza A (H3N2) virus (once it infects a human) Note: This virus is called swine influenza A (H3N2) until the virus has infected a human. Once it infects a human, it is considered a variant virus and should be called influenza A (H3N2)v.
Initial Setting	Thomas County Fair Swine Barn or farm
Initial Reservoir	Show Pig
Method of Transmission A	**Direct Transmission** • **Direct contact.** For example, an infected pig coughs or sneezes the virus up from its lower respiratory tract through the mouth or nose, which typically remains contaminated in infected pigs. A person (human #1) may then directly touch the pig's nose or mouth, which transferred the virus to his or her hands. Human #1 may then touch his or her own eyes, nose, or mouth and caused an infection. • **Droplet spread.** For example, the infected show pig could cough or bark, or sneeze, which caused droplets containing virus to enter the eyes, nose, or mouth of a nearby person (human #1). **Indirect Transmission** • **Contaminated environments or contaminated surfaces (i.e., fomites).** For example, the infected pig could cough or bark, or sneeze, which caused droplets that contained virus to contaminate the surrounding environment and surfaces, such as the pigs' food or water trough, or even a fence enclosure. A person (human #1) could then touch one of these contaminated surfaces and then touch his or her eyes, nose, or mouth, which resulted in an infection. Alternatively, an infected pig could eat or drink from a feeding trough, which allowed nasal or oral secretions to contaminate the trough. Human #1 could pick up the trough and then touch his or her own eyes, nose, or mouth and caused an infection.
Host A	Human #1. For example, a person who had cared for or had shown a pig, or someone passing through the swine barn and who touched or stood close to the swine when they sneezed or coughed.
Method of Transmission B	**Direct Transmission** • **Direct contact.** For example, infected human #1 could touch their eyes, nose, or mouth and then touch the eyes, nose, or mouth of an uninfected family member. Infected human #1 could also kiss a family member. Alternatively, infected human #1 could cough or sneeze into their hands and then touch the family member's eyes, nose, or mouth and caused an infection. • **Droplet spread.** (common scenario) For example, human #1 could cough or sneeze, which allowed droplets that contained the virus to travel through the air and enter the eyes, nose, or mouth of a nearby family member. **Indirect Transmission** • **Contaminated environments or contaminated surfaces (i.e., fomites).** For example, the infected person may cough or sneeze, which allowed droplets that contained the virus to contaminate a nearby surface or object, such as a doorknob, food plate or glass, or article of clothing. An uninfected family member may then touch that contaminated surface or object and then touch his or her own eyes, nose, or mouth and caused an infection.
Host B	Family member of Human #1

Story Map Outline	Human-Human-Human
Virus	Human seasonal influenza A (H1N1) virus
Initial Setting	Ferris wheel
Initial Reservoir	Human #1. For example, a family member, friend, student, or colleague.
Method of Transmission A	**Direct Transmission** • **Direct contact.** For example, an infected human (human #1) could touch his or her own eyes, nose, or mouth and then touch the eyes, nose, or mouth of an uninfected person (human #2). Human #1 could also kiss human #2. Alternatively, infected human #1 could cough or sneeze into his or her hands and then shake hands with an uninfected person (human #2). Human #2 could then touch his or her own eyes, nose, or mouth, which resulted in an infection. • **Droplet spread.** (common scenario) For example, human #1 could cough or sneeze, which caused droplets that contained the virus and enter the eyes, nose, or mouth of a nearby person (human #2) and caused an infection. **Indirect Transmission** • **Contaminated environments or contaminated surfaces (i.e., fomites).** For example, an infected person (human #1) may cough or sneeze, which caused droplets containing virus to contaminate a nearby surface or object, such as a doorknob, a food plate or glass, or an article of clothing. Human #2 may then touch that contaminated surface or object and then touch his or her own eyes, nose or mouth and caused an infection.
Host A	Human #2. For example, a family member, friend, student, or colleague.
Method of Transmission B	**Direct Transmission** • **Direct contact.** For example, infected human #2 could touch his or her own eyes, nose, or mouth and then touch the eyes, nose, or mouth of an uninfected person (human #3). Human #2 could also kiss human #3. Alternatively, infected human #2 could cough or sneeze into his or her hands and then shake hands with another uninfected person (human #3). Human #3 could then touch his or her own eyes, nose, or mouth and caused an infection. • **Droplet spread.** (common scenario) For example, infected human #2 could cough or sneeze causing droplets that contain virus and enter the eyes, nose, or mouth of a nearby person (human #3) and caused an infection. **Indirect Transmission** • **Contaminated environments or contaminated surfaces (i.e., fomites).** For example, infected human #2 may cough or sneeze, which allowed droplets that contained virus to contaminate a nearby surface or object, such as a doorknob, food plate or glass, or article of clothing. Human #3 may then touch that contaminated surface or object and then touch his or her own eyes, nose, or mouth and caused an infection.
Host B	Human #3

Story Map Outline	Human-Human-Pig
Virus	Human seasonal influenza A (H3N2) virus
Initial Setting	Shopping Mall
Initial Reservoir	Human #1. For example, a family member, friend, student, or colleague.
Method of Transmission A	**Direct Transmission** • **Direct contact.** For example, an infected human (human #1) could touch his or her own eyes, nose, or mouth and then touch the eyes, nose, or mouth of an uninfected person (human #2). Human #1 could also kiss human #2. Alternatively, infected human #1 could cough or sneeze into his or her hands and then shake hands with an uninfected person (human #2). Human #2 could then touch his or her own eyes, nose, or mouth and resulted in an infection. • **Droplet spread.** (common scenario) For example, human #1 could cough or sneeze, which caused droplets that contain the virus to enter the eyes, nose, or mouth of a nearby person (human #2) and caused an infection. **Indirect Transmission** • **Contaminated environments or contaminated surfaces (i.e., fomites).** For example, an infected person (human #1) may cough or sneeze, which allowed droplets that contain the virus to contaminate a nearby surface or object, such as a doorknob, food plate or glass, or article of clothing. Human #2 may then touch that contaminated surface or object and then touch his or her own eyes, nose, or mouth and caused an infection.
Host A	Human #2. For example, a family member, friend, student, or colleague.
Method of Transmission B	**Direct Transmission** • **Direct contact.** For example, infected human #2 touches his or her eyes, nose, or mouth and then touches the eyes, nose, or mouth of an uninfected pig. Alternatively, the infected human could cough or sneeze into his or her hands and then touches the eyes, nose, or mouth of the uninfected pig and resulted in an infection. • **Droplet spread.** For example, while in the swine barn, human #2 could cough or sneeze, which allowed droplets that contain the virus to enter the eyes, nose, or mouth of a nearby pig. **Indirect Transmission** • **Contaminated environments or contaminated surfaces (i.e., fomites).** For example, the infected person could cough or sneeze in the swine barn, which allowed droplets that contain virus to contaminate the surrounding environment and surfaces, such as the pig's food or water trough. The pig could then touch, eat, or drink from one of these contaminated surfaces and resulted in an infection. Alternatively, an infected person could touch his or her own eyes, nose, or mouth and then touches the pig's feeding trough or other objects in the pig's immediate environment. This can also occur when a person coughs or sneezes into his or her hand and then touches such objects. Pig #1 can then become infected through contact (by the eyes, nose, or mouth) with these contaminated surfaces.
Host B	Pig #1