Vector-Borne Disease Research Project

Disease ______________________________________

Group Members ____

Each group will research a vector-borne disease using reliable sources (.gov, .edu) and report findings in a PowerPoint presentation or an informational brochure.

Project must include the following information:

- Pathogen (bacterium, protozoan or virus) and scientific name
- Vector
- Incubation period
- Stages in the life cycle of the disease
- Symptoms
- Treatment or cures, if applicable. What happens if disease is not treated?
- Geography and population affected
- Additional information pertaining to the disease (not just a list of websites)
- Citation page

Presentations are graded as follows:

Information	60 points	Information	______ points
Visuals	10 points	Visuals	______ points
Professional Presentation	10 points	Professional Presentation	______ points
Creativity	10 points	Creativity	______ points
Project Participation	10 points	Project Participation	______ points
TOTAL	**100 points**	**TOTAL**	______ points

Disease Options:

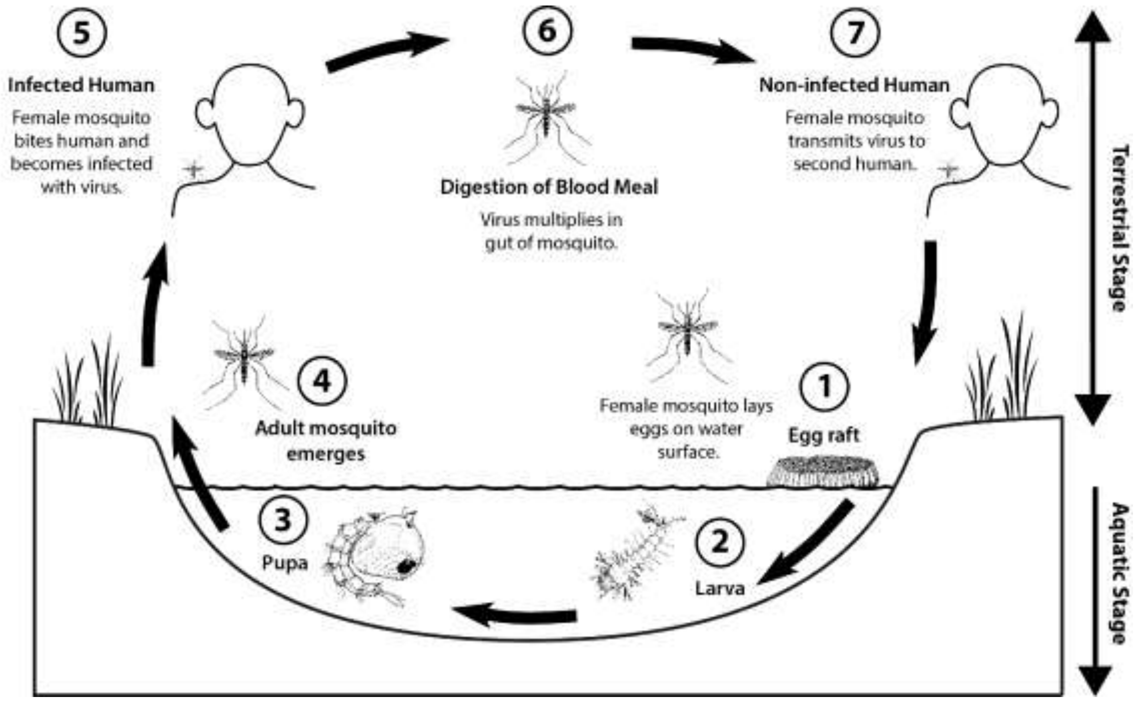
- Chikungunya
- Dengue
- Leishmaniasis
- Lyme disease
- Malaria
- West Nile virus
- Yellow fever

Disease Transmission Terminology

Vector: any organism capable of carrying a pathogen from one organism to another; vector-borne diseases can be transmitted from animals to humans (or from humans to humans) that have been bitten by an infected mosquito, tick or flea

Pathogen: a microorganism–such as a bacterium, virus or protozoan–that can cause disease

Example: *Aedes* mosquitoes are vectors that carry the dengue and chikungunya virus pathogens from an infected human to a non-infected human.



Incidence: occurrence, rate or frequency of a disease in a particular area; how often a disease occurs in an area

Example: Incidence of vector-borne diseases has increased worldwide since the early 1800s.

Distribution: geographic area where a disease occurs, such as a country, state, city or town

Local Transmission occurs when a mosquito bites someone who is infected with the virus and then bites another person. A disease becomes established in a new area once local mosquitoes start transmitting it from infected to non-infected human residents.

Imported Cases: An imported case occurs when a person contracts the virus in one country and transports it to another country where the disease is not present. Most epidemics start with an infected individual carrying a disease to a new area where a suitable vector exists.

Doctor's Notes
Infectious Disease Diagnosis Activity

Doctors at an Infectious Disease Clinic will interview several patients today who complain of feeling sick. When taking their medical histories, doctors will ask questions and patients will explain their symptoms, how long they have been sick, and their travel histories. Doctors will do their best to diagnose the ailments from a combination of clues (symptoms, duration of symptoms, travel history, and other information).

Patients are encouraged to obtain second and third opinions from other clinics.

Doctors may use disease brochures or projects to check off symptoms on the **Symptoms Chart**. They may also refer to the **Doctor's Notes** about infectious diseases with information from the Centers for Disease Control and Prevention (CDC) website.

To track a patient's symptoms, doctors will use the **Patient Chart** to take notes during the visit.

Use **Health Map** (healthmap.org/en/) to create additional disease maps to identify where each disease occurs.

1. Malaria

www.cdc.gov/malaria

Symptoms: Fever, chills, sweats, headaches, nausea, vomiting, body aches, malaise, elevated temperature, perspiration, weakness, enlarged spleen, mild jaundice (yellowing of skin), enlarged liver, increased respiratory rate

Incubation Period: 7 to 30 days

Vector: Mosquito (*Anopheles*)

Pathogen: Protozoa (*Plasmodium falciparum, P. vivax, P. ovale,* and *P. malariae*)

Disease Map: www.cdc.gov/malaria/about/distribution.html

2. Dengue
www.cdc.gov/dengue

Symptoms: High fever, severe headache, severe pain behind the eyes, joint pain, muscle pain, bone pain, rash, mild nose or gum bleeding, easy bruising, low white cell count

Incubation Period: 4 to 10 days after mosquito bite

Vector: Common house mosquito **(***Aedes aegypti*), Asian Tiger Mosquito (*Aedes albopictus*)

Pathogen: Dengue virus

Disease Map: www.cdc.gov/dengue/epidemiology/index.html

3. Lyme Disease
www.cdc.gov/lyme

Symptoms: Bull's eye rash, fatigue, chills, fever, headache, muscle and joint aches, swollen lymph nodes

Incubation Period: 3 to 30 days

Vector: Deer tick (*Ixodes scapularis*)

Pathogen: Spirillium bacteria (*Borrelia burgdorferi*)

Disease Map: www.cdc.gov/lyme/stats/index.html

4. Leishmaniasis
www.cdc.gov/leishmaniasis

Symptoms: Cutaneous leishmaniasis: one or more painless ulcers, infections with pus

Incubation Period: Several weeks to years

Vector: Female sandfly (*Phlebotomus papatasi*)

Pathogen: Protozoan (*Leishmania*)

Disease Map: www.cdc.gov/parasites/leishmaniasis/epi.html

5. West Nile Virus

www.cdc.gov/westnile

Symptoms: Fever, headache, fatigue, body aches, occasional skin rash (on the trunk of the body), swollen lymph glands, stiff neck, stupor, disorientation, coma, tremors, convulsions, muscle weakness, paralysis

Incubation Period: 2 to 15 days

Vector: Common Brown Mosquito (*Culex pipiens*)

Pathogen: West Nile virus

Disease Map: diseasemaps.usgs.gov/mapviewer

6. Yellow Fever

www.cdc.gov/yellowfever

Symptoms: Sudden onset of high fever, chills, severe headache, back pain, general body aches, nausea, vomiting, weakness, jaundice (yellow skin and eyes)

Incubation Period: 3 to 6 days

Vector: Common house mosquito (*Aedes aegypti*)

Pathogen: Yellow fever virus

Disease Map: www.cdc.gov/yellowfever/maps/index.html

7. Chikungunya

www.cdc.gov/chikungunya

Symptoms: Fever and joint pain (can last up to a month), headache, muscle pain, joint swelling or rash; does not often result in death, but symptoms can be severe and disabling

Incubation Period: 3 to 7 days

Vector: Common house mosquito **(***Aedes aegypti*), Asian Tiger Mosquito (*Aedes albopictus*)

Pathogen: Chikungunya virus

Disease Map: www.cdc.gov/chikungunya/geo/index.html

Patient Stories: Student Version
Infectious Disease Diagnosis Activity

Samantha

Samantha had a great spring break vacation with her parents to the island of Trinidad. She was at the beach a few days and also explored the countryside. Samantha came home from vacation on a Sunday and was back at school on Monday. By Wednesday she was not feeling well. She had a fever and also felt weak and had the chills. The school nurse sent Samantha home to rest. When her mom came home, she saw that Samantha's eyes were yellow and her fever was getting higher.

John

John's parents recently went on a Caribbean cruise and visited several islands. A few days after they came home to Florida, John's father became very ill. He had a severe headache, extreme muscle aches and swollen joints, and developed a rash around his torso. He was better after about a week. Before becoming ill, John and his father worked outdoors in the yard every day at dawn and dusk to avoid the heat. Now John is starting to feel achy and feverish.

José

José went to visit his extended family in Brazil for the summer. He reconnected with his old friends by playing soccer every day. But a few months after getting home, José noticed red spots on his skin. The spots are growing and oozing pus. Some of them have become ulcers. José and his mother are very worried!

Maggie

Maggie is a high school student who lives in Connecticut. Yesterday, Maggie was at the mall when a stranger noticed that she was disoriented. When the stranger asked whether she was okay, Maggie said that she had a severe headache and her neck was stiff. She also noticed that her lymph nodes were swollen and her body was sore all over.

Tara

Tara is a college student who spent last summer at a wilderness camp in India. The camp was 40 miles outside of the city of Mumbai. She worked with underprivileged children as a volunteer for a youth organization. She spent 30 days as a canoeing instructor. Tara really enjoyed working with the children, but near the end of her stay she began to feel sick. She remembers waking up one night with sweats and extreme nausea. That was the third week into her stay. The symptoms reminded her of the flu she had last winter, but they were stronger and lasted longer. Tara continued to feel sick the next week. Then she was vomiting and had a fever. Tasks that had been easy, such as rowing a canoe with a few children, were now difficult. She was often short of breath. When her father picked her up at the airport, he told his daughter that her skin was "yellow." It's October now, but Tara still has many of the same symptoms, and her complexion has not returned to its usual color.

Sebastian

Sebastian is a junior on his high school's baseball team. When he returned home from practice on a hot August afternoon he felt exhausted and achy. He also had a headache and pressure behind his eyes. Sebastian thought his headache was probably from playing baseball in the hot sun all day. He went to his room and lay down to rest. About a half hour later, his mother called him to dinner. On his way downstairs, he stopped in the bathroom. Sebastian looked in the mirror and noticed that his face was pale and blotchy. A moment later his nose began to bleed. He wondered why he was feeling so badly. Just a week earlier, when he visited his grandparents in San Juan, Puerto Rico, he was soaking up the sun and feeling great.

Kelly

Kelly is a freshman in high school. She enjoys hiking with her dog at their favorite park in New York's Hudson Valley. This spring the weather has been beautiful, so she has been hiking more often than usual. Kelly was in her first period Spanish class yesterday when she realized that her ankle joints and leg muscles were aching. She thought her aches and pains must be from all the hiking she has been doing. When she came home after school, she was tired and decided to get into some comfortable clothes and rest. That's when she noticed a strange round rash about the size of a grapefruit on her stomach.

Patient Stories: Teacher Version
Infectious Disease Diagnosis Activity

Samantha – Yellow Fever

Samantha had a great spring break vacation with her parents to the island of Trinidad. She was at the beach a few days and also explored the countryside. Samantha came home from vacation on a Sunday and was back at school on Monday. By Wednesday she was not feeling well. She had a fever and also felt weak and had the chills. The school nurse sent Samantha home to rest. When her mom came home, she saw that Samantha's eyes were yellow and her fever was getting higher.

John – Chikungunya

John's parents recently went on a Caribbean cruise and visited several islands. A few days after they came home to Florida, John's father became very ill. He had a severe headache, extreme muscle aches and swollen joints, and developed a rash around his torso. He was better after about a week. Before becoming ill, John and his father worked outdoors in the yard every day at dawn and dusk to avoid the heat. Now John is starting to feel achy and feverish.

José – Leishmaniasis

José went to visit his extended family in Brazil for the summer. He reconnected with his old friends by playing soccer every day. But a few months after getting home, José noticed red spots on his skin. The spots are growing and oozing pus. Some of them have become ulcers. José and his mother are very worried!

Maggie – West Nile Virus

Maggie is a high school student who lives in Connecticut. Yesterday, Maggie was at the mall when a stranger noticed that she was disoriented. When the stranger asked whether she was okay, Maggie said that she had a severe headache and her neck was stiff. She also noticed that her lymph nodes were swollen and her body was sore all over.

Tara – Malaria

Tara is a college student who spent last summer at a wilderness camp in India. The camp was 40 miles outside of the city of Mumbai. She worked with underprivileged children as a volunteer for a youth organization. She spent 30 days as a canoeing instructor. Tara really enjoyed working with the children, but near the end of her stay she began to feel sick. She remembers waking up one night with sweats and extreme nausea. That was the third week into her stay. The symptoms reminded her of the flu she had last winter, but they were stronger and lasted longer. Tara continued to feel sick the next week. Then she was vomiting and had a fever. Tasks that had been easy, such as rowing a canoe with a few children, were now difficult. She was often short of breath. When her father picked her up at the airport, he told his daughter that her skin was "yellow." It's October now, but Tara still has many of the same symptoms, and her complexion has not returned to its usual color.

Sebastian – Dengue Fever

Sebastian is a junior on his high school's baseball team. When he returned home from practice on a hot August afternoon he felt exhausted and achy. He also had a headache and pressure behind his eyes. Sebastian thought his headache was probably from playing baseball in the hot sun all day. He went to his room and lay down to rest. About a half hour later, his mother called him to dinner. On his way downstairs, he stopped in the bathroom. Sebastian looked in the mirror and noticed that his face was pale and blotchy. A moment later his nose began to bleed. He wondered why he was feeling so badly. Just a week earlier, when he visited his grandparents in San Juan, Puerto Rico, he was soaking up the sun and feeling great.

Kelly – Lyme Disease

Kelly is a freshman in high school. She enjoys hiking with her dog at their favorite park in New York's Hudson Valley. This spring the weather has been beautiful, so she has been hiking more often than usual. Kelly was in her first period Spanish class yesterday when she realized that her ankle joints and leg muscles were aching. She thought her aches and pains must be from all the hiking she has been doing. When she came home after school, she was tired and decided to get into some comfortable clothes and rest. That's when she noticed a strange round rash about the size of a grapefruit on her stomach.

Symptoms Chart

Disease

		Malaria	Dengue	Leishmaniasis	Lyme Disease	West Nile Virus	Chikungunya	Yellow Fever
Temperature	Fever							
	Chills							
	Sweats							
	Perspiration							
Digestive	Nausea & Vomiting							
	Vomiting Blood							
	Diarrhea							
Pain	Body Aches							
	Headaches							
	Severe Pain Behind Eyes							
	Joint Pain							
	Muscle Pain							
	Muscle Weakness							
	Bone Pain							
	Abdominal Pain							
	Paralysis							
	Neck Stiffness							
Internal	Weight Loss							
	Respiratory Issues							
	Swollen Lymph Glands							
	Organ Failure							
	Enlarged Spleen							
	Enlarged Liver							

Symptoms Chart

Disease

		Malaria	Dengue	Leishmaniasis	Lyme Disease	West Nile Virus	Chikungunya	Yellow Fever
Skin	Bleeding							
	Red Rash on Skin							
	Bull's Eye Rash							
	Jaundice (yellowing)							
	Painless Ulcer							
	Easy Bruising							
	Cyanosis (blue skin)							
Mood / Brain Function	Drowsiness							
	Weakness / Fatigue							
	Irritability							
	Disorientation/ Stupor							
	Convulsions							
	Tremors							
	Shock							

Comments / Notes

-

Patient Chart

Patient

		Samantha	John	Maggie	Kelly	José	Tara	Sebastian
Temperature	Fever							
	Chills							
	Sweats							
	Perspiration							
Digestive	Nausea & Vomiting							
	Vomiting Blood							
	Diarrhea							
Pain	Body Aches							
	Headaches							
	Severe Pain Behind Eyes							
	Joint Pain							
	Muscle Pain							
	Muscle Weakness							
	Bone Pain							
	Abdominal Pain							
	Paralysis							
	Neck Stiffness							
Internal	Weight Loss							
	Respiratory Issues							
	Swollen Lymph Glands							
	Organ Failure							
	Enlarged Spleen							
	Enlarged Liver							

Patient Chart

Patient

		Samantha	John	Maggie	Kelly	José	Tara	Sebastian
Skin	Bleeding							
	Red Rash on Skin							
	Bull's Eye Rash							
	Jaundice (yellowing)							
	Painless Ulcer							
	Easy Bruising							
	Cyanosis (blue skin)							
Mood / Brain Function	Drowsiness							
	Weakness / Fatigue							
	Irritability							
	Disorientation/ Stupor							
	Convulsions							
	Tremors							
	Shock							
	Diagnosis							

Doctor Notes

	Samantha	John	Maggie	Kelly	José	Tara	Sebastian
Travel / Locale							
Duration of symptoms							
Recent activities							
Other							

Disease Transmission: Contributing Factors

Transmission of insect-borne diseases involves many factors other than climate and seasonal weather changes.

Biological Interactions

Invasive Species

Changes in local climate and environment can allow non-native species to move into new areas, possibly carrying diseases that have not been in the area before.

Insecticides

Insecticides can become less effective over time as mosquitoes adapt to the chemicals.

Environmental Factors

Irrigation

Irrigation of rice fields provides ideal habitats for mosquito larvae.

Deforestation

Deforestation affects rainfall that can create and destroy mosquito habitats.

Wastewater Drains

Organic material from farms, sewage and lawn clippings can concentrate in storm drains, promoting mosquito development.

Drought

Higher temperatures and low rainfall reduce larger bodies of water into isolated pools ideal for some vector mosquitoes.

Water Storage

During dry seasons in tropical areas, people collect water in uncovered rain barrels where mosquitoes can lay eggs.

Social & Economic Conditions

Overcrowding

People are migrating into cities in greater numbers, where mosquitoes can more easily transmit disease.

Global Travel

People can travel farther and faster than ever before, possibly carrying diseases to new areas.

Refugees

Refugees gather in camps where water storage and waste disposal provide new mosquito habitats.

Mosquito Control

When government funds for vector surveillance and control are cut, mosquito populations will again increase.

Public Education

People often discontinue personal protective measures after an educational campaign reduces threat of disease.

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Buzz Buzz Bite!
Disease Transmission Simulation Game
Teacher Notes

PART I (Direct Transmission): a classic direct disease transmission lab often used to demonstrate HIV or influenza transmission from person-to-person contact.

Part II (Indirect Transmission): an adaptation of this lab to simulate indirect transmission of vector-borne diseases. This section demonstrates transmission of the chikungunya virus (ChikV) by *Aedes* sp. mosquitoes, causing the disease chikungunya in humans.

Reagents (measurements do not need to be exact)

<u>Infected Solution</u>	Sodium carbonate (washing soda): 1 g (approx. 1/4 teaspoon) 100 mL water
<u>Indicator Solution</u>	Phenolphthalein: 0.1 g (approx. 1/4 of 1/8 teaspoon) 100 mL ethyl or 70% isopropyl (rubbing) alcohol

Phenolphthalein indicator will turn dark pink or red in the presence of a base (washing soda).

Non-toxic Reagents (measurements do not need to be exact)

<u>Infected Solution</u>	2 tbsp. baking soda 500 mL of water
<u>Indicator Solution</u>	1/4 tsp. turmeric 4 tbsp. isopropyl (rubbing) alcohol

Turmeric indicator solution will turn orange or red in the presence of a base (baking soda).

Game Play

Depending on grade level and the number of students in your class, students can play both parts of the game in approximately one 50-minute class period.

This timeframe does not include discussion of direct and indirect transmission and the chikungunya virus, which is necessary to understand the lesson. You may find this information in the introduction to the Student Lab and in the exhibit panel on chikungunya.

If you have many students, it might be more time efficient to split the class. Half of the students play **Part I** while the others observe and record data; then they switch roles for **Part II**. Everyone gets to play one version of the game, but there is less movement in the classroom and less data to analyze. Some teachers assign the data analysis for homework to save class time.

Procedures

Part I – Direct Transmission (Human to Human)

1. This activity requires an even number of students.
2. Number the cups sequentially: 1, 2, 3, etc.
3. Each student takes a cup of fluid and a pipet.
4. Approximately 10% of the class should receive "infected" solution and the rest of the cups should contain water. Fill all cups with the same volume of fluid and record the cup numbers of those "infected." Be careful to avoid cross-contamination.
5. The following suggestions may help you keep track of exchanges:
    - Project a blank chart from the handout onto your smart board or screen using a document camera.
    - Post a chart or paper on the board for the students or teacher to fill in data after each exchange.
    - Attach a sticky note to each cup to record exchanges.
6. Use logic to determine the transmission pathway and identity of the initial infected patient.

Part II – Indirect Transmission (Human to Vector to Human)

1. This activity requires an even number of students: half *Mosquitoes* and half *Humans*.
2. Assign roles to students or allow them to select for themselves.
3. Number the cups sequentially: M1, M2, M3, etc. for *Mosquitoes*; H1, H2, etc. for *Humans*.
4. Each student takes a cup of fluid, but only *Mosquitoes* take a pipet because *Humans* do not bite *Mosquitoes*. All *Mosquitoes* are females that must feed on blood to develop their eggs. The pipet represents the mosquito proboscis (mouthpart) that bites and takes a blood meal.
5. Only *Humans* will be initially "infected" in this activity, to demonstrate how infected humans can transmit pathogens indirectly to uninfected humans through a mosquito vector. Approximately 10% of the *Humans* should receive "infected" solution and the rest of the cups should contain water. Fill all cups with the same volume of fluid and record the cup numbers of those "infected." Be careful to avoid cross-contamination.
6. The following suggestions may help you keep track of the exchanges:
    - Project a blank chart from the handout onto your smart board or screen using a document camera.
    - Post a chart or paper on the board for the students or teacher to fill in data after each exchange.
    - Attach a sticky note to each cup to record exchanges.
7. Use logic to determine the transmission pathway and identity of the initial infected patient.

Buzz Buzz Bite!
Disease Transmission Simulation Game
Part 1: Direct Transmission—Human to Human

Direct human-to-human disease transmission can result from direct contact (touching, bodily fluids), or indirect contact (touching an infected surface). Diseases spread through direct transmission include the common cold, influenza (flu), and acquired immune deficiency syndrome (AIDS).

Instructions
Each cup of liquid represents human bodily fluids. Someone will receive fluids "infected" with a disease. You do not know who is "infected" and who is not, but this investigation will allow you to figure out who introduced the disease into the population. That person is the index patient, or Patient Zero.

Materials (for each student)
- One disposable cup (numbered) with unknown liquid
- One disposable plastic pipet

> **Caution:** Some of the liquids are poisonous to taste or touch. Do not drink any fluids in this lab. If a liquid spills on your skin, wash it off immediately with plenty of cold water.

Procedure
1. Choose a cup and pipet.
2. Record your cup number below.
3. Students with odd-numbered cups form an inner circle.
4. Students with even-numbered cups walk around the outside of the circle.
5. Only exchange once per round.
6. Do not exchange with the same person twice.

Round 1
1. When instructed, students in the outer circle will begin to walk around the inner circle. When the teacher gives the signal, stop and stand in front of someone in the inner circle.
2. Once everyone has a partner, squirt two pipets full of fluid from your cup into the cup of the person in front of you. Your partner will do the same. Stir with the pipet.
3. Record your partner's cup number below. Wait for everyone else to finish.

Round 2
1. When instructed, the outer circle will walk around the inner circle again and each student will find a new partner.
2. Repeat the fluid exchanges just as in Round 1. Do not exchange with the same person twice.
3. Record your new partner's cup number below. Wait for everyone else to finish.

Round 3

1. Repeat this procedure one more time. Be sure to find a new partner and do not exchange with the same person twice.
2. Return to your seat.

Final Step

Your teacher will add an indicator solution to each cup. “Infected” students will see a color change.

Data Collection

Your Cup Number _____

Partner Cup Numbers

- Round 1 _____
- Round 2 _____
- Round 3 _____

Conclusion

Complete the Direct Transmission Data Chart to track disease transmission.

Who is Patient Zero? What is your evidence?

Did any errors occur in this lab? If so, how do you think these errors will affect the results?

Do you think that this lab accurately depicts how an epidemiologist would look for a Patient Zero? Explain.

Buzz Buzz Bite!
Disease Transmission Simulation Game
Part 2: Indirect Transmission—Human to Vector to Human

The second part of this activity simulates indirect vector-borne disease transmission. Transmission is indirect when humans transmit the disease to other humans, but not directly person-to-person.

A vector, such as a mosquito, picks up the pathogen (disease-causing organism) from an infected human and passes it to an uninfected human. One person transmits disease to another person, even though there is no direct contact. Examples of vector-borne diseases: chikungunya, dengue fever, and malaria.

Materials (for each student)

- One disposable cup (numbered) with unknown liquid
- One disposable plastic pipet (*Mosquitoes* only!)

> **Caution:** Some of the liquids are poisonous to taste or touch. Do not drink any fluids in this lab. If a liquid spills on your skin, wash it off immediately with plenty of cold water.

Procedure

1. Each student chooses a cup, but only *Mosquitoes* choose a pipet.
2. Record your cup number below.
3. *Humans* form an inner circle.
4. *Mosquitoes* move around the outside of the circle.
5. Only exchange once per round.
6. Do not exchange with the same person twice.

Round 1

4. When instructed, *Mosquitoes* in the outer circle will begin to move around *Humans* in the inner circle. When the teacher gives the signal, stop and stand in front of someone in the inner circle.
5. Once everyone has a partner, each *Mosquito* will "bite" a *Human* and squirt two pipets full of fluid from his or her cup into the *Human* cup. (Infected mosquitoes can transmit virus in saliva.) Stir with the pipet.
6. *Mosquitoes* then take two pipets full of fluid from the *Human*'s cup. (When taking a blood meal, a mosquito can consume virus in the human's blood.)
7. Record your partner's cup number below. Wait for everyone else to finish.

Round 2

4. When instructed, the outer circle will move around the inner circle again and each student will find a new partner.
5. Repeat the fluid exchange just as in Round 1. Do not exchange with the same person twice.
6. Record your new partner's cup number below. Wait for everyone else to finish.

Round 3

3. Repeat this procedure one more time. Be sure to find a new partner and do not exchange with the same person twice.
4. Return to your seat.

Final Step

Your teacher will add an indicator solution to each cup. “Infected” students will see a color change.

Data Collection

Your Cup Number _____

Partner Cup Numbers

- Round 1 _____
- Round 2 _____
- Round 3 _____

Conclusion

Complete the Indirect Transmission Data Chart to track disease transmission.

Who is Patient Zero? What is your evidence?

Did any errors occur in this lab? If so, how do you think these errors will affect the results?

Do you think that this lab accurately depicts how an epidemiologist would look for a Patient Zero? Explain.

Buzz Buzz Bite!

Your Cup # _____

Round 1 Cup # _____ Round 2 Cup # _____ Round 3 Cup #_____

DIRECT TRANSMISSION DATA CHART

	Round 1	Round 2	Round 3	Results
Cup #	Cup #	Cup #	Cup #	(+/–)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				

Buzz Buzz Bite!

Your Cup # ______

Round 1 Cup # ______ Round 2 Cup # ______ Round 3 Cup #______

INDIRECT TRANSMISSION DATA CHART

	Round 1	Round 2	Round 3	Results
Cup #	Cup #	Cup #	Cup #	(+/-)
M1				
M2				
M3				
M4				
M5				
M6				
M7				
M8				
M9				
M10				
M11				
M12				
H1				
H2				
H3				
H4				
H5				
H6				
H7				
H8				
H9				
H10				
H11				
H12				

Disease Transmission: Contributing Factors

Transmission of insect-borne diseases involves many factors other than climate and seasonal weather changes.

Biological Interactions

Invasive Species

Changes in local climate and environment can allow non-native species to move into new areas, possibly carrying diseases that have not been in the area before.

Insecticides

Insecticides can become less effective over time as mosquitoes adapt to the chemicals.

Environmental Factors

Irrigation

Irrigation of rice fields provides ideal habitats for mosquito larvae.

Deforestation

Deforestation affects rainfall that can create and destroy mosquito habitats.

Wastewater Drains

Organic material from farms, sewage and lawn clippings can concentrate in storm drains, promoting mosquito development.

Drought

Higher temperatures and low rainfall reduce larger bodies of water into isolated pools ideal for some vector mosquitoes.

Water Storage

During dry seasons in tropical areas, people collect water in uncovered rain barrels where mosquitoes can lay eggs.

Social & Economic Conditions

Overcrowding

People are migrating into cities in greater numbers, where mosquitoes can more easily transmit disease.

Global Travel

People can travel farther and faster than ever before, possibly carrying diseases to new areas.

Refugees

Refugees gather in camps where water storage and waste disposal provide new mosquito habitats.

Mosquito Control

When government funds for vector surveillance and control are cut, mosquito populations will again increase.

Public Education

People often discontinue personal protective measures after an educational campaign reduces threat of disease.

SEPA SCIENCE EDUCATION PARTNERSHIP AWARD
Supported by the National Institutes of Health

Yale PEABODY MUSEUM OF NATURAL HISTORY

Humans vs. Mosquitoes
Game History

In 2011 a group of Yale University professors assigned their graduate students to help the international Red Cross and Red Crescent teach people how mosquito-borne diseases such as dengue fever and malaria could expand with climate change. The Yale students got together with student game designers from The New School's Parsons School of Design and they invented ***Humans* vs. *Mosquitoes*** (http://HumansvsMosquitoes.com).

Games are a great way to teach a lesson while having fun, so adults learn along with the children. Since its creation, adults and children around the world have played this game to learn how simple actions can help stop the spread of dangerous diseases. Thousands of people of all ages have learned the game in Kenya, South Africa, Uganda, Vietnam and the Philippines.

Game Focus
To educate the public about the following:

- risk factors for dengue, especially those related to climate change
- consequences of human behaviors that affect the spread of dengue

Over 2.5 billion people worldwide are at risk of contracting dengue. From 50 to 100 million cases of dengue fever and 250,000 to 500,000 cases of dengue hemorrhagic fever occur each year in more than 100 countries. Dengue—found in tropical and subtropical climates, and in urban and semi-urban areas—is spread by infected female *Aedes aegypti* mosquitoes. Four different viruses cause dengue. An infected person will develop lifelong immunity to that specific virus and transient immunity to the other three viruses.

There is no vaccine, cure or specific treatment for dengue fever, so prevention remains the only effective strategy. Dengue can be prevented through control of the mosquito population with biological, chemical and environmental methods. The International Red Cross and Red Crescent promotes dengue interventions that focus on the importance of clearing mosquito habitats rather than using insecticides. This game highlights the importance of prevention, especially by clearing mosquito habitats.

Climate change will influence the transmission of dengue. Fluctuations in rainfall, warmer weather and water shortages will all increase the prevalence of this disease. The International Red Cross and Red Crescent is one of the humanitarian agencies that are actively responding to the healthcare effects of climate change by organizing education and habitat clearing campaigns to reduce the spread of dengue in countries such as Peru, Bolivia and Paraguay. Climate change will place a greater burden on humanitarian agencies responding to dengue epidemics. These organizations will require increased support to reach the most vulnerable populations worldwide.

Humans vs. Mosquitoes

Object of the Game

Demonstrate how climate change will affect humans, mosquitoes, and the transmission of vector-borne infectious diseases.

Target Audience

- Children in developing countries where vector-borne diseases such as malaria and dengue fever are prevalent.
- Red Cross Red Crescent workers, parents, teachers, physicians and nurses in developing countries.
- Participants at conferences on climate change and governmental and non-governmental health agencies (United Nations, World Health Organization, Red Cross Red Crescent)
- Students in the United States in grades 6–12.

Number of Players

A minimum of six players and one facilitator are needed to play the game. Designate three players as *Humans* and three as *Mosquitoes*. Divide the rest of the class into two groups—**Team HUMAN** and **Team MOSQUITO**—that provide support and strategy to these players. Players can trade places with teammates at any time throughout the game.

Time Required

30–45 minutes.

Game Equipment

- **Table space** for each group of six players.
- **6 Habitats:** Laminated pictures of places where *Mosquitoes* can lay eggs that will hatch (birdbath, freshwater marsh, vernal pool, tire dump, rainwater barrels, and rain gutters).
- **23 Blood Tokens** (red glass pebbles or small river rocks): A blood token has multiple functions. It represents eggs for *Mosquitoes*, larvae for habitats, and health for *Humans*.
- **8 Climate Cards** (like Chance Cards in *Monopoly*®): These cards introduce a realistic scenario that connects climate change, mosquito behavior, human susceptibility to disease and humanitarian aid.
- **6 Nametags** for players.
- **6-Sided game die** to roll to determine which *Mosquito* dies when a habitat is cleared.

Game Plan

Play the game like *Rock, Paper, Scissors* mixed with *Freeze Tag*. When the facilitator says "1,2,3, GO!" each player commits to an action and freezes.

Play

Both teams just want to stay alive! It is better if the *Humans* win, but this is not always the outcome.

- *Mosquitoes* win if they kill all the *Humans* first, by depleting their health!
- *Humans* win if they kill all the *Mosquitoes* first, by clearing out habitats where eggs hatch into larvae!

Who Will Survive?

Game Setup

In developing countries, people play the game without store-bought game pieces. Facilitators must be resourceful in finding game pieces such as rocks, sticks or small pieces of paper. Using rocks allows players to imagine that they are learning the game in a developing country, the way Red Crescent workers teach it.

1. Select 1 facilitator to run the game and keep track of every intended action. The facilitator also collects blood tokens when a *Mosquito* bites or a *Human* kills a larva.
2. Select 3 *Humans* and give them 12 blood tokens to divide. Divide up all tokens so *Mosquitoes* do not know which *Humans* have the most tokens and are healthiest. *Humans* stand on one side of the table and hide their tokens.
3. Select 3 *Mosquitoes* and give them 2 blood tokens to divide up so *Humans* do not know who has extra eggs. *Mosquitoes* stand on the opposite side of the table and hide their tokens. All *Mosquitoes* are female. Blood tokens represent eggs for a *Mosquito*, as she must feed on blood to develop her eggs, which hatch into larvae.
4. Set up 3 habitats at the start of the game. The *Mosquitoes* can distribute 9 blood tokens among all 3 habitats (where they will lay their eggs) any way they want. Suggestion: Habitat #1 = 2 tokens; Habitat #2 = 4 tokens; Habitat #3 = 3 tokens.

Students who are not actively playing the game can split up and advise the players on strategy.

- **Team *HUMAN*** helps the *Humans* decide how to distribute their blood tokens (health).
- **Team *MOSQUITO*** helps the *Mosquitoes* strategize about egg placement in habitats.

Rules

- Blood transfusions are not allowed! One *Human* cannot give blood tokens to another *Human*.
- *Mosquitoes* cannot transfer eggs between themselves.
- Any *Mosquito* can lay eggs in any habitat**.**
- A *Mosquito* dies when a habitat is cleared. Roll the game die to determine which *Mosquito* dies. All of a *Mosquito's* eggs are lost when that *Mosquito* dies.
- Players must indicate clearly which action they intend to take. *Mosquitoes* must point **clearly** at the *Human* they intend to bite or at the habitat where they plan to lay an egg that will hatch into a larva. *Humans* must point **clearly** at the habitat where they intend to kill a larva. Players cannot change their minds after seeing other players' actions.
- *Humans* cannot directly kill adult *Mosquitoes*. In real life, it is far more difficult for *Humans* to kill adult *Mosquitoes* than to clear the habitats where eggs hatch into larvae.

Troubleshooting

- **"This game isn't fair!"** *Humans* have a slight statistical advantage, which reflects real life. It would be inappropriate to give students the idea that *Mosquitoes* could overcome *Humans* in this scenario.
- **Do not allow shortcuts.** If a *Mosquito* bites a *Human* and then that *Human* kills a larva, allow both players to carry out their respective actions. Do not allow the *Mosquito* to take a shortcut by taking a larva from the habitat. Even though this is the net result of these two

actions, the purpose of each individual action would be lost or confused.

- ***Humans* cannot protect themselves all the time**. *Humans* are tempted to protect themselves, rather than risk *Mosquito* bites by killing a larva. Sometimes all three *Humans* may protect themselves. If so, take this opportunity to discuss how that strategy would be not be effective in real life and will not allow the game to move forward.

Playing the Game

Rounds: When the facilitator says "1, 2, 3, GO!" each player must commit to an action and freeze. The facilitator then acknowledges players individually and allows each one to carry out an action. Discuss how this situation might reflect real life, according to what happened in the round.

- Short Version: The facilitator collects transferred blood tokens when a *Mosquito* bites a *Human* or a *Human* kills a larva. Limiting the number of blood tokens in circulation allows the game to resolve within a few rounds. This will allow more student participation if you change roles between rounds.
- Long Version: If a *Mosquito* bites a *Human*, the *Mosquito* takes a blood token, which reduces the *Human*'s health and symbolically turns into an egg. If a *Human* takes a larva from a habitat, that *Human* keeps the blood token and is symbolically healthier (as in less likely to be bitten and infected). Keeping blood tokens in circulation lengthens the game, allowing more climate cards to be introduced to the game.

In each round, *Humans* have the choice to protect themselves from *Mosquito* bites or to clear out a habitat and prevent *Mosquitoes* from multiplying there. *Humans* cannot directly kill adult *Mosquitoes*.

Mosquitoes must either lay eggs in a habitat or bite a *Human*. *Mosquitoes* do not kill *Humans* directly by biting, but they take a blood token when they bite. This weakens *Human* health by increasing the chance of disease transmission.

- *Humans* with few blood tokens could represent people who are more susceptible to disease because they are very old or very young, are already sick with another disease, or are malnourished.
- *Humans* with many blood tokens could be young and healthy or have good access to healthcare and nutritious foods.

	Goals	Game Actions
MOSQUITOES	(1) Bite *Humans* and feed on blood to develop eggs that hatch into larvae. (2) Lay eggs to repopulate habitats with larvae	(1) Point at a *Human*. (2) Point at a habitat.
HUMANS	(1) Protect yourself from *Mosquito* bites. (2) Kill larvae by clearing out habitats.	(1) Cross arms over chest. (2) Point at a habitat.

Play a few rounds to help students learn the game. Then start using climate cards to change the course of the game. Draw cards randomly and follow the instructions on the card, or select cards to fit the situation or lesson. Climate cards can allow *Mosquitoes*, *Humans* or habitats to “come back to life” under certain circumstances.

A habitat is lost when *Humans* have cleared all the blood tokens (killed all of the larvae in the habitat). Remove the habitat from the table. One *Mosquito* must die when a habitat is cleared. Roll the game die to determine which *Mosquito* dies. All of a *Mosquito’s* eggs are lost when that *Mosquito* dies.

Humans die when they run out of blood tokens (health). Players are on the honor system to report that they have no more blood tokens.

Conclusion
When one game ends, switch roles and begin a new game. Ask players to write a description of what happened in the game and how this reflects real life issues.

HABITAT

Birdbath

A birdbath is a favorite backyard spot for female mosquitoes to lay eggs. Cleaning out birdbaths regularly will destroy any eggs or larvae already present. Removing organic debris will also eliminate potential food sources and prevent mosquitoes from completing their life cycle.

HABITAT

SeppVei, via Wikimedia Commons

Rain Gutters

Rain gutters that do not drain completely can hold water and dead leaves, providing a perfect habitat for mosquitoes to lay eggs. This gutter is angled so that water runs out.

HABITAT

Jan Tik (Flickr) [CC---BY---2.0 (http://creativecommons.org/licenses/by/2.0)], via Wikimedia Commons

Rainwater Barrels

In some countries, people collect rainwater in open barrels. They also use open containers to store water from wells, streams or rivers. Mosquitoes often lay eggs in these containers.

HABITAT

U.S. National Archives and Records Administration, Record Group 412: Records of the Environmental Protection Agency, 1944-2006
ARC Identifier 542531. Photographer: Gene Daniels.

Tire Dump

Safe disposal of used tires is difficult, so people may discard them in dumps. Piles of old tires can provide a perfect habitat for mosquitoes to lay eggs and for larvae to develop into adults.

HABITAT

Nicholas A. Tonelli from Pennsylvania, USA (Vernal Pool) [CC-BY-2.0 (http://creativecommons.org/licenses/by/2.0)], via Wikimedia Commons

Vernal Pool

Vernal pools are temporary pools or ponds formed by winter rains or melting snow. The word “vernal” means “spring”, the season when the pools have the most water. They may dry up for the rest of the year but often cycle between wet and dry depending on rainfall. Vernal pools are a great place for mosquitoes to lay eggs, because the water is very still and usually has no fish.

HABITAT

The U.S. Geological Survey's SOFIA Kid's Page (http://sofia.usgs.gov/virtual_tour/kids/ecosys.html) via Wikimedia Commons

Freshwater Marsh

Freshwater marshes are wetlands. They are mostly standing water with grasses and very few trees or shrubs. Marshes are rich in organic matter, because particles suspended in the water settle out as the current slows. Mosquitoes lay eggs on the still water and the larvae have plenty of dead, organic matter to eat. Draining marshes can prevent mosquitoes from growing there; however, marshes are also a good habitat for fish and other useful organisms.

Name ____________________________________ Class __________________________ Date _____________

Humans vs Mosquitoes: What Do You Think?

1. **Before the game**
   - After hearing the rules of the game, who do you think **will** win: *Humans* or *Mosquitoes*? Why?

   - Who do you think **should** win: *Humans* or *Mosquitoes*? Why?

2. **During the game**
   - How did **your** team strategize?

   - How did the **other** team strategize?

3. **After the game**
   - Who won? Why do you think this happened?

   - How does the game relate to real life? How is the game different from real life?

   - Read the background information about *Humans vs Mosquitoes*. Do you think this game is an effective way to teach people how dengue fever or other vector-borne diseases spread? Why or why not?

Name ___________________________________ Class _________________________ Date _______________

Humans vs. Mosquitoes: Scenarios

Increased Rainfall	**Humanitarian Aid**	**Warmer Temperatures**
Land Use Conversion	**Drought**	**Mosquito Adaptations**

1. __________________________ The International Red Cross and Red Crescent visits your school and teaches how to prevent dengue by clearing habitats instead of using insecticides. People are healthier because now they empty standing water instead of using insecticides.

2. __________________________ Mosquitoes that previously laid eggs only in clean water now lay eggs in dirty water if that is all that is available. They can live in new habitats where they did not live before.

3. __________________________ As temperatures increase, relative humidity decreases. Adult mosquitoes will die in drier than normal conditions.

4. __________________________ Farmers clear land of natural vegetation to use it for agriculture. Changes in runoff, drainage patterns and irrigation create new places for mosquitoes to lay eggs.

5. __________________________ The International Red Cross and Red Crescent visits your community and organizes a campaign to clear out mosquito habitats. As a result, people empty or cover water containers.

6. __________________________ Some areas will have more rain than usual. Rain fills open containers and creates new places where mosquitoes can lay eggs.

7. __________________________ Water shortages occur during drier than normal conditions. People save water in open containers where mosquitoes can lay eggs.

8. __________________________ As temperatures increase, the mosquito life cycle speeds up creating a mosquito “baby boom.” Mosquitoes develop from eggs to larvae to pupae faster so that more generations of mosquitoes are born.

Humans vs. Mosquitoes: Scenarios
Teacher Key

Increased Rainfall	**Humanitarian Aid**	**Warmer Temperatures**
Land Use Conversion	**Drought**	**Mosquito Adaptations**

1. ____**Humanitarian Aid**_______ The International Red Cross and Red Crescent visits your school and teaches how to prevent dengue by clearing habitats instead of using insecticides. People are healthier because now they empty standing water instead of using insecticides.

2. ____**Mosquito Adaptations**___ Mosquitoes that previously laid eggs only in clean water now lay eggs in dirty water if that is all that is available. They can live in new habitats where they did not live before.

3. ____**Warmer Temperatures**___ As temperatures increase, relative humidity decreases. Adult mosquitoes will die in drier than normal conditions.

4. ____**Land Use Conversion**_____ Farmers clear land of natural vegetation to use it for agriculture. Changes in runoff, drainage patterns and irrigation create new places for mosquitoes to lay eggs.

5. ____ **Humanitarian Aid** ______ The International Red Cross and Red Crescent visits your community and organizes a campaign to clear out mosquito habitats. As a result, people empty or cover water containers.

6. ____**Increased Rainfall**______ Some areas will have more rain than usual. Rain fills open containers and creates new places where mosquitoes can lay eggs.

7. ____**Drought**________________ Water shortages occur during drier than normal conditions. People save water in open containers where mosquitoes can lay eggs.

8. ____**Warmer Temperatures**___ As temperatures increase, the mosquito life cycle speeds up creating a mosquito “baby boom.” Mosquitoes develop from eggs to larvae to pupae faster so that more generations of mosquitoes are born.

A Tale of Twin Cities and One Insect-Borne Disease

Dengue fever is widespread in Asia, Africa, South and Central America, but not in the United States. Worldwide, 50-100 million infections occur yearly with 20,000 deaths, mainly children. No vaccine or cure currently exists. Even though the climate in the southern U.S. is suitable and the mosquito vector *Aedes aegypti* lives here, many fewer people get dengue fever in the U.S. than in neighboring Mexico. Over a 10-year period, only 64 cases of dengue fever were confirmed in Texas, while 62,514 cases were reported in three adjoining Mexican states.

Nuevo Laredo, Mexico
(Population 290,000)

Laredo, Texas
(Population 200,000)

The two cities are so close together across the Rio Grande that local people consider it to be one big city, *Los Dos Laredos*, or "The Two Laredos."

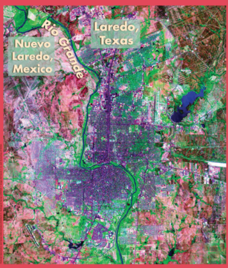
Similarities

Differences

HIGH TRANSMISSION

Fewer window screens & air conditioners
Doors and windows stay open in homes and public places.

More crowded
Houses are closer with more people per house.
More low income neighborhoods (shown in pale blue-violet)



Satellite image (false color composite) shows Laredo, Texas (east of the Rio Grande river) and Nuevo Laredo, Taumalipas (west of the river).

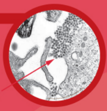
MINIMAL TRANSMISSION

More window screens & air conditioners
Dry air in cooled homes and businesses kills mosquitoes.

Less crowded
Houses are farther apart with fewer people per house.
Fewer low income neighborhoods *(shown in pale blue-violet)*

Climate change can affect disease transmission, but in this case scientists conclude that socioeconomic factors are more important in explaining why there is more dengue fever in Nuevo Laredo than in neighboring Laredo.

Dengue Fever
(Break Bone Fever)



Dengue fever virus particles

Symptoms: High fever, severe headache, rash; joint, muscle and bone pain
Treatment: Bed rest, increased fluids, pain medication
Prevention: Bed nets, insect repellant

SEPA SCIENCE EDUCATION PARTNERSHIP AWARD
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