


4-2

Modeling Vector Disease Transmission

Objective

In this task, the team will model the spread and transmission of a disease among a group of mosquitoes (vector) and humans (host). The team will use the model to explore how a disease can move through a group of humans (hosts) using a mosquito (vector). We will also explore how different factors can affect disease transmission.

In this task, the team will be focusing on the following questions from the question map. How do mosquitoes spread disease? What factors influence this?

1. Go to the Task 4-2 folder and get the Modeling Vector Disease Transmission activity. Choose the Mosquito A or Mosquito B version of the task. Remember, both can be played inside or outside. You decide! 
2. Run as many models as you can, following the task instructions. Collect and compile the data.
3. Compare and contrast the results of different model setups. What effect does the model have on the transmission rate?
4. As a team, discuss the following:
 - Were more or fewer people infected than you expected?
 - What are some ways this model does not accurately model mosquito-human interactions?
 - What factors can affect how quickly a disease spreads through a group of mosquitoes and humans?
 - What other factors do these models not incorporate? How could you incorporate them into the model?
5. Develop a new model of your own using this setup. Run the model and compare the results.
 - How can models like these be useful when thinking about questions on the map, such as what factors influence how mosquitoes spread diseases? How can we ensure health for all from mosquito-borne diseases?





Task 4-2 Modeling Vector Disease Transmission Activity—Mosquito A

Follow the directions to set up the model to explore vector disease transmission through a group of people.

Use the Model numbers chart at the end of this document to determine how many people will model humans and how many will model mosquitoes, based on the total number of team members.

Model 1

- All humans start uninfected.
- The number of infected mosquitoes is determined by the table. Do not let the humans or other mosquitoes know which mosquito is infected before the round begins.
- Run the model according to the instructions below.

Model 2

- Start with 10 percent of the humans already infected (so 90 percent uninfected).
- Based on the chart, start with the designated number of infected mosquitoes. Do not let the humans or other mosquitoes know who is infected.

Model 3

Follow the same setup as Model 2, but increase number of infected mosquitoes at the start.

Model 4

Follow the same setup as Models 1 or 2, but increase the number of times each mosquito can “bite” in each round. For example, each mosquito bites four or five people in a round. What effect does this have on the results?





Instructions for Running the Model

1. Humans and mosquitoes will slowly roam around the room or in an outside area. There is no talking during this activity.
2. Mosquitoes will tag a human. When they do, they will simulate biting the human by shaking their hand.
3. If the mosquito is infected, the mosquito should squeeze the human's hand twice when shaking their hand, to let them know they are now infected. No talking, and do not share this information with anyone else.
4. The human is now infected and will squeeze the hand of other mosquitoes to infect them.
5. Once a human is infected, the human should also squeeze the hand of a mosquito twice. If the mosquito was uninfected, but then bites an infected human, they are now infected.
6. The mosquito will then move on to another human.
7. Each mosquito will "bite" a total of three people during each model round. Note that a human can be bitten by more than one mosquito during a round.
8. After all mosquitoes have bitten three people, have the mosquitoes and humans stand in separate areas.
9. All infected humans and mosquitoes then raise their hands.
10. Count how many mosquitoes and humans are infected at the end of each round.
11. Use the data collection sheet to compile the data.
12. Repeat the model using different model setups.
13. Compare and contrast results of different model setups. What effect does the model have on the transmission rate?





Model Numbers Chart

Total # of team members	Humans	Total # of mosquitoes	Infected mosquitoes
10	8	2	1
11	8	3	1
12	9	3	1
13	10	3	1
14	11	3	1
15	11	4	1
16	12	4	1
17	13	4	2
18	14	4	2
19	14	5	2
20	15	5	2
21	16	5	2
22	17	5	2
23	17	6	2
24	18	6	2
25	19	6	2
26	20	6	2
27	20	7	2
28	21	7	2
29	22	7	2
30	23	7	2
31	23	8	3
32	24	8	3
33	25	8	3
34	26	8	3
35	26	9	3
36	27	9	3
37	28	9	3
38	29	9	3
39	29	10	3
40	30	10	3
41	31	10	3
42	32	10	3
43	32	11	4
44	33	11	4
45	36	11	4
46	35	11	4
47	35	12	4
48	36	12	4
49	37	12	4
50	38	12	4



Data Table

Model setup	# of humans	# of infected humans to start	# of infected humans at end of round	# of mosquitoes	# of infected mosquitoes to start	# of infected mosquitoes at end of round	Notes

Go back to Research Guide now





Task 4-2 Modeling Vector Disease Transmission Activity—Mosquito B

Follow the directions to set up the model to explore vector disease transmission through a group of people.

Materials

- Use the Model numbers chart at the end of this document to determine how many people will model humans and how many will model mosquitoes, based on the total number of team members. This will also tell you how many human and mosquito cups you will need.
- Have one small cup for each human and one for each mosquito. Label each with a number.
- Have one eye dropper, pipette or syringe for each mosquito
- Infected and uninfected solutions (see below)
- Vinegar

Uninfected Solution: Mix 1 liter of water with 1 cup of flour. Mix well.

Infected Solution: Mix 1 liter of water with $\frac{1}{2}$ cup flour and $\frac{1}{2}$ cup baking soda. Mix well.

The team will use these materials to run various models. Use the setups described for each model. Then use the instructions to run each model.

Clean and rinse all cups and pipettes between each round.

Model 1

1. Fill all of the humans' cups with uninfected solution.
2. Give each human a numbered cup.
3. Based on the chart, fill the designated number of mosquito cups with infected solution. Fill the others with uninfected solution. Document which numbered cups contain the infected solution. Do not tell mosquitoes whether or not they are infected.
4. Run the model according to the instructions below.

Model 2

5. Fill 10 percent of the humans' cups with infected solution to start. Document which numbered cups contain the infected solution.
6. Fill the other 90 percent of the humans' cups with uninfected solution.
7. Give each human a numbered cup. Do not let the infected people know they are infected.
8. Based on the chart, fill the designated number of mosquito cups with infected solution. Fill the others with uninfected solution. Document which numbered cups contain the infected solution. Do not tell mosquitoes whether or not they are infected.





Model 3

Follow the same setup as Model 2, but increase number of infected mosquitoes at the start.

Model 4

Follow the same setup as Models 1 or 2, but increase the number of times each mosquito can “bite” in each round. For example, each mosquito bites four or five people in a round. What effect does this have on the results?

Instructions for Running the Model

1. Humans and mosquitoes will slowly roam around the room or in an outside area. There is no talking during this activity.
2. Mosquitoes will tag a human. When they do, they will simulate biting the human by squirting all of their liquid into the human’s cup using the eye dropper, pipette, or syringe.
3. The mosquito will then simulate feeding by mixing the contents in the human’s cup and filling their cup with half the solution from the human’s cup, using the eye dropper, pipette, or syringe.
4. The mosquito will then move on to another human.
5. Each mosquito will “bite” a total of three people during each model round. Note that a human can be bitten by more than one mosquito during a round.
6. After all mosquitoes have bitten three people, have the mosquitoes stand at the front of the team.
7. Each mosquito and human cup will now be tested for infection. To test each cup, pour a small amount of vinegar in each cup and swirl the solution.
 - If the cup bubbles, the person is infected.
 - If the cup does not bubble, the person is not infected.
8. Use the data collection sheet to compile the data.
9. Clean out all cups and pipettes.
10. Repeat the model using fresh solutions and different model setups.
11. Compare and contrast the results of different model setups. What effect does the model have on the transmission rate?





Model Numbers Chart

Total # of team members	Humans	Total # of mosquitoes	Infected mosquitoes
10	8	2	1
11	8	3	1
12	9	3	1
13	10	3	1
14	11	3	1
15	11	4	1
16	12	4	1
17	13	4	2
18	14	4	2
19	14	5	2
20	15	5	2
21	16	5	2
22	17	5	2
23	17	6	2
24	18	6	2
25	19	6	2
26	20	6	2
27	20	7	2
28	21	7	2
29	22	7	2
30	23	7	2
31	23	8	3
32	24	8	3
33	25	8	3
34	26	8	3
35	26	9	3
36	27	9	3
37	28	9	3
38	29	9	3
39	29	10	3
40	30	10	3
41	31	10	3
42	32	10	3
43	32	11	4
44	33	11	4
45	36	11	4
46	35	11	4
47	35	12	4
48	36	12	4
49	37	12	4
50	38	12	4



