

## Unit 2: Lesson 3 – Discovery and Development of Vaccines

### Activity 2: Understanding Herd (Community) Immunity

Consider the following scenario. Three schools participate in a basketball tournament. High School's students are almost totally vaccinated. Low School's students are mostly unvaccinated. A student from the third school is unknowingly infected with measles. After the tournament, several people in Low School become infected with measles. Even some people who did not attend the tournament are infected. Yet no one in High School becomes infected, even unvaccinated students. High School's students are protected by herd immunity. Because enough people are immune, the population (even the unvaccinated) is protected from a disease outbreak.

In this activity, you will run a computer simulation to test how different immunization rates determine:

1. The percentage of the total population that becomes infected
2. The percentage of the unvaccinated population that becomes infected

#### Materials

Each group will need a computer with internet access and the activity data table and activity questions included in this packet.

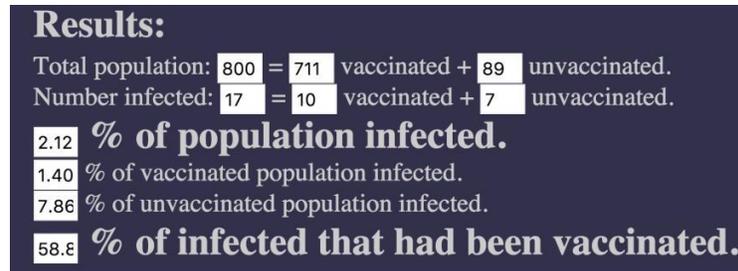
#### Procedure

1. Work in pairs. Choose to be either the simulation operator or the recorder. You can switch roles at any time.
2. To begin the simulation, visit the website:  
<http://www.software3d.com/Home/Vax/Immunity.php>
3. You will see a field of cells (asterisks), representing vaccinated (green) and unvaccinated cells.
4. Below the field of cells you will see a box containing the variables you can set for the simulation. You will only change the immunization rate (from the default value).

Immunization rate on left:	<input type="text" value=".9"/>	Immunization rate on right:	<input type="text" value=".9"/>	<input checked="" type="checkbox"/> Same as left
Infection rate if not vaccinated:	<input type="text" value=".9"/>	Infection rate if vaccinated:	<input type="text" value=".1"/>	<input type="button" value="Repopulate"/>
Infection speed:	<input type="text" value="10"/>			

5. Check the "Same as left" box to keep the immunization rate on the left side the same as the right. Keep the infection rates and infection speed set to the default values.

6. The default is 0.9 on both the right and left sides. Set the immunization rate to the value provided by your teacher. (The value will be from 0.1 to 0.9). Record this immunization rate in the space provided above your Herd Immunity Simulator Data Table (page 3 in this activity packet).
7. Click on an unvaccinated cell (red asterisk) to infect it.
8. From the Results section in the simulation, record the percent figures resulting from you infecting a cell in your Herd Immunity Simulator Data Table (page 3 of packet).



9. Click the Repopulate button, and repeat the procedure from Step 7 nine more times. You will have 10 trials, using the same immunization rate.
10. Once you have collected the data for your simulations, enter it in a spreadsheet (such as Excel or Numbers).
11. Calculate the average and standard deviation for your data.
12. Your teacher will provide a collaborative document to share your data with the class, called "pooling" data.
13. Graph the pooled data using a spreadsheet or graphing tool. Once you have compiled all of the data, plot the class data on a scatter graph. Plot the immunization rate on the horizontal (x) axis. Plot the percent of population infected on the vertical (y) axis. Plot the percent of the vaccinated population infected on the same graph.
14. Graph the remaining two columns of pooled data, again plotting the immunization rate on the x axis. On the y axis, plot the percent of unvaccinated population infected (this represents the percent of the population infected that was unvaccinated). Also on the y axis plot the percent infected that had been vaccinated.
15. Use the Pooling Class Data Table (page 4 of packet) and the graphs made in steps 13 and 14 to answer the Activity 2 questions.

### Herd Immunity Simulator Data Table

Enter the data from your herd immunity simulations into the table below and calculate the statistics.

Immunization rate \_\_\_\_\_

Trial	% population infected	% vaccinated population infected	% unvaccinated population infected	% infected had been vaccinated
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
Mean				
SD				

**Pooling Class Data Table**

Record the mean percentages from the pooling class data in this tables and use it to answer the questions.

Immunization rate	% population infected	% vaccinated population infected	% unvaccinated population infected	% infected had been vaccinated
0.1				
0.2				
0.3				
0.4				
0.5				
0.6				
0.7				
0.8				
0.9				

1. Explain the relationship between immunization rate and percent of population infected.
2. How does the percent of the unvaccinated population who are infected change as the immunization rate increases?
3. Is there a point in your data where the unvaccinated population seems to be protected from infection? Explain your answer.
4. Predict what happens when the immunization rate is 0 and then 1.0. Explain your answer.
5. Check your answer to #4 by running the simulation with the immunization rate at 0 and then 1.0. Did you predict the simulation result correctly? Explain the simulation result.