

How R_0 Shapes an Epidemic

Name: _____

Date: _____

Student worksheet—*Answer key*

Part 1: What does a disease's R_0 mean?

- Navigate to the [How \$R_0\$ Shapes an Epidemic Notebook](https://sbgo.org/rnaught) (<https://sbgo.org/rnaught>) at SimPandemic. SimPandemic is an online simulator that lets you explore how various factors change a pandemic's evolution. Read through scenarios 1-2 and study the accompanying tables and graphs.
- Use the information in the SimPandemic Notebook to answer questions 1-4.

1. Measles has an R_0 that ranges from 12-18. What does this mean in terms of how infectious the disease is?

It means that, on average, a person who has measles will infect 12 to 18 people.

2. What are three factors that contribute to the R_0 of an infectious disease?

The infectious period of the disease.

The mode of transmission of the disease.

The contact rate between individuals.

3. In your own words, explain why the R_0 of a disease might change from one community to another.

Students should identify that one of the three factors that influences R_0 is contact rate between individuals, and different communities have different contact rates. The greater the contact rate in the community, the higher the R_0 .

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4. Does an epidemic occur when a disease has an R_0 of less than 1? Explain why or why not. (Hint: Think about what having an R_0 of less than 1 means and the definition of an epidemic).

No epidemic will occur when an infectious disease has an R_0 of less than 1. Having an R_0 of less than 1 means that, on average, an infected person either does not pass along the disease or only passes it to one other person. This means that over time, the number of people who have the disease at any one time drops. This is the opposite of what happens in an epidemic where there is a sudden increase in the number of people infected.

Part 2: How do different R_0 values change an epidemic?

In this part, you will use the Sandbox to run your own simulations. If you have questions about how to use the Sandbox, read the [FAQ](https://www.sciencebuddies.org/simpandemic/faq) (<https://www.sciencebuddies.org/simpandemic/faq>). Make sure to save your work as you go (see FAQ). When you have completed all your simulations, write or paste the URL for them here for your teacher to see:

Use what you learn from your own simulations to answer questions 5-7.

5. Follow the directions in the Sandbox portion of [How \$R_0\$ Shapes an Epidemic Notebook](https://sbgo.org/rnaught) (<https://sbgo.org/rnaught>) to change the R_0 . Run three simulations for each value of R_0 (2, 3, and 4). Fill in the information in the tables for each value and calculate averages.

Student numbers on the tables will vary slightly. The averages in the R_0 of 3 will serve as the baseline values. Expect to see numbers higher and lower than the baseline as described in the R_0 of 2 and R_0 of 4 tables.

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R_0 of 2				
	Simulation Run #1	Simulation Run #2	Simulation Run #3	Average
Total number of infections				<i>Lower than when R_0 is 3</i>
Total number of deaths				<i>Slightly smaller than when R_0 is 3</i>
First day the number of infections/day (blue line) above 1000				<i>Later than when R_0 is 3</i>
Last day the number of infections/day (blue line) above 1000				<i>Later than when R_0 is 3</i>
Total number of infections/day (blue line) were above 1000				<i>Larger than when R_0 is 3</i>
Largest value for infections/day (peak value for blue line)				<i>Smaller than when R_0 is 3</i>

R_0 of 3				
	Simulation Run #1	Simulation Run #2	Simulation Run #3	Average
Total number of infections				
Total number of deaths				
First day the number of infections/day (blue line) above 1000				
Last day the number of infections/day (blue line) above 1000				
Total number of infections/day (blue line) were above 1000				
Largest value for infections/day (peak value for blue line)				

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R_0 of 4				
	Simulation Run #1	Simulation Run #2	Simulation Run #3	Average
Total number of infections				<i>Higher than when R_0 is 3</i>
Total number of deaths				<i>Slightly larger than when R_0 is 3</i>
First day the number of infections/day (blue line) above 1000				<i>Sooner than when R_0 is 3</i>
Last day the number of infections/day (blue line) above 1000				<i>Sooner than when R_0 is 3</i>
Total number of infections/day (blue line) were above 1000				<i>Smaller than when R_0 is 3</i>
Largest value for infections/day (peak value for blue line)				<i>Larger than when R_0 is 3</i>

6. Based on your simulations, compare and contrast how a COVID-19 epidemic unfolds if the R_0 is low (2) versus high (4). Give examples using your data from question 5.

Students should cite specific information from their simulations. In general, they should see that with a low R_0 , the epidemic occurs over a longer period of time with fewer people infected at a time. In short, the infection curve is wider and flatter. The higher the R_0 , the steeper and narrower the infection curve, meaning that more people are infected over a shorter period of time.

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7. A disease's deadliness is a measure of how likely you are to die of the disease if you catch it. In other words, it is the percentage of infections that result in death (see equation). Based on this definition and your simulations, how does R_0 impact COVID-19's deadliness?

$$\% \text{ Viral Death} = \frac{\# \text{deaths}}{\# \text{infections}} \times 100$$

- ☐ A higher R_0 makes COVID-19 much more deadly.
- ☒ *COVID-19's deadliness is mostly independent of its R_0 .*
- ☐ A lower R_0 makes COVID-19 much more deadly.

Explain your reasoning.

The average number of deaths increases slightly as R_0 increases. However, total number of infections also rise as R_0 increases. Since both factors rise at the same time, the total percentage of deaths remains between 2-3%.