Comparing COVID-19 Variants

Student worksheet—*Answer key*

Part 1: What are virus variants and how are they created?

Use the information you learn in these resources to answer questions 1-6:

- **Understand COVID-19: Novel Coronavirus Mutations and Variants** (**https://sbgo.org/video-variants**)
- Sections 1 and 2 of the **Comparing COVID-19 Variants** SimPandemic Notebook (**https://sbgo.org/comparing-variants**)

Word Bank

copies	genetic information	machinery	virus particles
genetic information	host cell	new hosts	

1. Use each word/phrase in the Word Bank once to complete this explanation of how a virus replicates.

   A virus enters a _____*host cell*_____. The virus uses the _____*machinery*_____ in the host cell to copy the virus's _____*genetic information*_____ (either DNA or RNA depending on the type of virus).

   The _____*copies*_____ of the virus's _____*genetic information*_____ are packaged into new _____*virus particles*_____ that can be spread to new cells or _____*new hosts*_____.

2. What are virus variants? [*Hint*: use the word *mutation(s)* in your answer!]

   A virus variant is any copy of the virus which carries one or more mutations.

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3. How are virus variants created? [*Hint*: look back at your answer to question 1 and think about how that process is altered to create a variant]

   A virus variant is created when the host cell's machinery makes an error in copying the virus's genetic information.

4. Define these terms in your own words:

   Transmissibility of a virus:

   Transmissibility refers to spread of a virus from one infected individual to others. When talking about transmissibility scientists are interested in understanding when and how the virus spreads.

   Virulence of a virus:

   Virulence characterizes how likely it is that an individual who is infected with a virus will have disease symptoms and the severity of those symptoms including the likelihood of death.

   A virus's basic **reproduction number** (R_0):

   R_0 describes the transmissibility of a virus. It is equivalent to the number of people, on average, an infected individual will infect.

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5. Fitness refers to how well an organism is adapted to survive in its environment. The more fit a virus is, the more likely it can go on to successfully infect new hosts and replicate. Define these types of mutations in terms of how they effect a virus's fitness.

   Harmful mutation:

   A mutation that decreases a virus's fitness. Harmful mutations make it less likely that the virus will survive.

   Beneficial mutation:

   A mutation that increases a virus's fitness. Beneficial mutations make it more likely that a virus will survive.

   Neutral mutation:

   A mutation that does not change the virus's fitness. Neutral mutations have no effect on the likelihood of a virus surviving.

6. Label each type of mutation as harmful, beneficial, or neutral from the virus's point of view. Explain your reasoning for each one.

   Mutation #1: This mutation changes a protein on the outside of the virus particle making it harder to enter a host cell.

   Harmful.
   If the virus cannot enter, it cannot be replicated by the host and is less likely to survive.

   Mutation #2: This mutation is found in the proof-reading mechanism of the virus but does not change the virus's ability to proofread.

   Neutral.
   This mutation does not change a characteristic of the virus, so it does not have any effect on the virus's fitness.

   Mutation #3: This mutation makes the virus easier for the human immune system to detect.

   Harmful.
   If the virus is detected by the host it is more likely to be eliminated by the host.

   Mutation #4: This mutation makes an infected patient more likely to sneeze and cough.

   Beneficial.
   if the host is sneezing and coughing the virus is more likely to be spread through a sneeze or cough to another host.

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Part 2: How do outbreaks caused by COVID-19 virus variants compare to outbreaks by the original COVID-19 virus?

Use Part 3 of the **Comparing COVID-19 Variants**, SimPandemic Notebook (**https://sbgo.org/video-variants**) to run simulations. Record your data from the simulations in the tables. Use the data to support your claims in questions 7-10.

Original COVID-19 Virus				
	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				

COVID-19 Alpha Variant				
	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				

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COVID-19 Delta Variant				
	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				

COVID-19 Omicron (BA.1) Variant				
	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				

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COVID-19 Omicron (BA.2) Variant				
	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				

COVID-19 Omicron (BA.2.12.1) Variant				
	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				

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7. Which COVID-19 variant is most transmissible? Back up your claim with data from your simulations.

   Students should see that the Omicron variants are the most transmissible. They may not be able to distinguish from the simulations which Omicron variant is the most transmissible as the total numbers infected and the speed for the epidemic will be very similar. However, they may have caught in the reading (or by pressing the "View Settings" button and checking the "Disease Characteristics") that Omicron BA.2.12.1 has the highest R_0.

8. Compared to the original COVID-19 strain, would a community have more, less, or the same amount of time to react to an outbreak of each variant you simulated? Back up your claim with data from your simulations.

   Students should see that there would be less time to react. The infection curves appear sooner and are steeper with the variants than with the original strain.

9. From a public health perspective, which strain of COVID-19 would be most difficult to deal with. Back up your claim with data from your simulations.

   Students may answer this any way as long as they back up their claim with data. For example, students may argue that it is the original strain because it still makes the hospitals over capacity, the outbreak lasts longer than with the other strains, and the total deaths is higher than with the Omicron variants. Alternatively, students may argue that Omicron is most challenging because it happens so quickly that the hospitals and community are completely overwhelmed.

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10. The difference between the graphs of the three Omicron variants is small, even though the R_0 changes from 9.0 for Omicron (BA.1) to 15.1 for Omicron (BA.2.12.1). Can you explain why? [*Hint*: Use the "View Settings" button to compare the "Disease Characteristics" of the Omicron variants and all the other COVID-19 strains.]

    The latent period is so short for all the Omicron variants that the infection is moving through the community so fast that it doesn't matter if each person is infecting on average 9 or 15 people.