**Who is more likely to die of COVID-19?**

**NGSS:**

**LS4.D: Biodiversity and Humans**

**LS2.D: Social Interactions and Group Behavior**

**ETS1.B: Developing Possible Solutions**

Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value.

## [Sustaining Global Surveillance and Response to Emerging Zoonotic Diseases](https://www.ncbi.nlm.nih.gov/books/NBK215318/) gives a thorough background for the drivers of zoonotic diseases. The global human population has grown exponentially in the past century and requires an increasing supply of natural resources. Roads cut into pristine wilderness increase opportunities for human contact with organisms that spread zoonotic disease. Population movement, altered land and water-use patterns, intensified agricultural practices, deforestation and reforestation, and human and domestic animal encroachment on wildlife habitats also affect the movement of pathogens and contribute to cross-species pathogen transmission and the emergence of new epidemic diseases that affect humans and animals. [Coronavirus-19 is believed to have developed in bat populations](https://www.cdc.gov/coronavirus/2019-ncov/cdcresponse/about-COVID-19.html) in China.

When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs.

**Students will be able to…**

Gather and interpret data about the spread of disease from computer simulations.

Use mathematical and/or computational representations to support explanations of factors that affect the transmission of COVID-19.

Evaluate the claims, evidence, and reasoning that the complex interactions in the spread of COVID-19 infections through human populations are influenced by human social constructs.

Give evidence that the spread of COVID-19 infections exhibits the 4 main characteristics of complex systems:

* Complex systems are composed of multiple interacting parts, or agents, whose interactions give rise to the outcomes of the system. The agents are not "trying to" create the high-level system outcomes. Rather, the outcomes "emerge" as a result of interactions at the level of the agents.
* The function of a complex system cannot be predicted merely by examining the function of its parts.
* A complex system is decentralized and self-organizing, meaning there is no single leader who controls the formation, structure, or outcomes of the system.
* Small, often random, changes at the agent level can lead to large changes at the system level; conversely, large changes at the agent level do not necessarily lead to changes at the system level at all.

**Key Terms:** Coronavirus-19 (COVID-19), virus, zoonotic disease (zoonosis), pandemic, infection, transmission, carrier, respiratory disease, diabetes, fatal, food security, driver of disease, simulation, model, survivorship, mortality, bias

**Guiding Questions:** Who is more likely to die of COVID-19 and why? In what way(s) is the process of disease transmission a complex system?

## **Lesson Plan:**

**Engage:** Group discussion

Students work with the person next to them to list responses to the following question:

“What do we know about Coronavirus-19?”

Ask pairs of students to share out their ideas with the whole class while compiling a list on the board. Go down the list to see how many students know about, and agree or disagree, with each item. How can we know which of these items represents true, accurate information? In what way has our understanding of COVID-19 changed since it was first discovered? Why has our understanding changed?

Alone or in pairs, run this [basic simulation](https://www.slnova.org/jaschwar/projects/756186/) of disease transmission.

1. Record three of your own observations about the simulation:

1.

2.

3.

Now you will use a simulation that models the spread of a potentially fatal disease, however, the two different colored agents are not equally affected. The red spheres have the disease and are contagious. Assume the infection rate is the same as the basic simulation even though the population now consists of both yellow spheres and blue spheres that do not turn red even though they are infected. This time black spheres will appear that represent both yellow or red agents that have died from the disease.

Go ahead and run this [survivorship simulation](https://www.slnova.org/jaschwar/projects/756171/edit/) by clicking on the blue “setup” button on the left side of the black screen and then click on the blue “forever” right beneath the setup button. After 200 “hours” have passed, stop the simulation by clicking the “forever” button again.

1. Record three of your own observations about the simulation:

1.

2.

3.

You may have noticed that as the simulation moves forward, data is collected in the graph/data table below the forever button. To see a table of the data, click the grid button in the upper right corner of the graph/data table window. Assume the time is measured in hours. At the end of each trial, download the data by clicking the tiny “download” button in the upper right corner of the graph. Open the three excel sheets and for each one click on the ***Insert*** tab at the top of the page. Look for the charts in the center top and click on the picture that looks like a line graph =



Click on the box that says ***Line*** graph.

A graph of the data will appear in the center of the excel sheet.

1. Record three of your own observations about the three graphs:

 1.

 2.

 3.

Now calculate the percent of survivors of each color for all the three trials. (Divide the ending number of survivors by the beginning number of agents and multiply by 100) Calculate the average for each color. (Add the % for the three trials of each color together and divide by 3.)

**Percent survival of two colors**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Trial 1 | Trial 2 | Trial 3 | Average |
| Yellow | % | % | % | % |
| Blue | % | % | % | % |

1. Record three of your own observations about the data table:

 1.

 2.

 3.

1. What conclusion(s) can you make about this simulation? Support your conclusion(s) with evidence (observations) from the simulation.

**Explore**: Explore the data presented on the following websites and answer the questions below:

[Conditions contributing to deaths involving coronavirus disease 2019 (COVID-19), by age group, United States.](https://data.cdc.gov/NCHS/Conditions-contributing-to-deaths-involving-corona/hk9y-quqm)

1. According to this data table, who is most likely to die from COVID-19?
2. What pre-existing condition led to the most deaths overall?

**Explain:** Read the opinion article, [Who Is Most Likely to Die From the Coronavirus?](https://www.nytimes.com/interactive/2020/06/04/opinion/coronavirus-health-race-inequality.html)

 by Yaryna Serkez published in the New York Times on June 4, 2020. Respond to the following questions:

1. What is the author’s profession? Are you confident that the author has expertise in the area of COVID-19 research? Why or why not? Give evidence to support your response.
2. In the first paragraph, the author states that 9 out of 10 people who died from COVID-19 also shared which characteristic?
3. What increases the chances that people have that characteristic?
4. Why are those people affected more than others?

**Elaborate:** Open the simulation and work your way through the activities in this modeling activity:

[Parable of the Polygons](http://web.mit.edu/djwendel/www/biograph/polygons6-9-18-003/)

Answer the following questions:

1. What surprised you about the neighborhood patterns that emerged?
2. Do online social networks (e.g. Facebook, Reddit, Imgur) share any of the characteristics of this simulation? Might these characteristics affect one's ability to hear multiple perspectives on contentious issues?
3. How does this activity illustrate complex systems?
4. What do you think this simulation has to do with the spread of COVID-19?

**Evaluate:**

1. Students will evaluate and use evidence from each of the activities in this unit to make a claim about the cause of the disparity in the COVID-19 deaths of people of different income levels and different races in the U.S..
2. Students will evaluate evidence from each of the activities in this unit to determine whether disease transmission in a pandemic exhibits the four characteristics of a complex system. Students will use evidence from the activities and reasoning to support their claim.

Questions to lead the thinking process….

* Is zoonotic disease transmission composed of multiple interacting parts? Yes/No and explain your reasoning.
* Can we understand the zoonotic disease transmission process by looking at just one of the following: the biology of the viral infection, group behavior, economics, mobility, agriculture, or culture?
* Is there a single leader who controls the transmission of viral particles?
* Can small changes (for example of the agents’ behaviors) lead to larger changes at the system level?

**Additional Resources:**

[Race gaps in COVID-19 deaths are bigger than they appear](https://www.brookings.edu/blog/up-front/2020/06/16/race-gaps-in-covid-19-deaths-are-even-bigger-than-they-appear/)

[Why are Blacks dying at higher rates from COVID-19?](https://www.brookings.edu/blog/fixgov/2020/04/09/why-are-blacks-dying-at-higher-rates-from-covid-19/)

[Deaths involving coronavirus disease 2019 (COVID-19) by race and Hispanic origin group and age, by state](https://data.cdc.gov/NCHS/Deaths-involving-coronavirus-disease-2019-COVID-19/ks3g-spdg)

[Modeling the transmission of a communicable disease](http://www2.nau.edu/lrm22/lessons/disease/disease_lab.html)