# Rates of Change and COVID-19

In this module, you learned how the derivative describes the rate of change of a function. This concept is very useful when modeling real-world data. For example, when the COVID-19 pandemic reached the United States in 2020, scientists needed to determine how fast the coronavirus was spreading. In other words, they needed to determine the *rate of change* of the number of cases.

There are a number of sites that provide data about the number of COVID-19 cases. For the purposes of this discussion, we will use the worldometers website.
https://www.worldometers.info/coronavirus/country/us/
There are two graphs on this page that we will discuss.

- Total Coronavirus Cases in the United States
- Daily New Cases in the United States

Let the "Total Cases" graph represent the function $c(t)$ of US coronavirus cases reported as of day $t$. The "Daily New Cases" graph gives the daily *average* rate of change of $c(t)$. Using the notation of this lesson, the formula for this function would be $d(t) = \frac{c(t+1)-c(t)}{1} = c(t+1) - c(t)$.

The derivative $c'(t)$ would actually be the *instantaneous* rate of change of the number of cases. Since it would be very difficult to get the second-by-second case data, the function $d(t)$ serves as a good approximation for $c'(t)$.

Partner up with a classmate as instructed by your teacher and discuss the following questions:

1. The Daily New Cases function $d(t)$ reaches its highest value on January 08, 2021. What is that value?

2. Describe in words what this value means in terms of the rate of change of the Total Cases function $c(t)$.

3. Confirm the validity of this value by finding the Total Cases $c(t)$ on January 08, 2021 and January 07, 2021 and subtracting.

4. The COVID-19 virus is spread most easily at large gatherings with lots of people in close contact. Many people won't show symptoms of the disease until a few days after coming into contact with the virus, and then they may wait longer before

going to the doctor. Can you think of any events just prior to January 08 that might explain the spike in the number of daily new cases?

5. The function $c(t)$ will never *decrease*, since it is a summary of the total cases reported. Ideally though, we would like to see the function stop *increasing*, which means the graph should "flatten out" or become roughly horizontal. What would need to happen to the Daily New Cases function $d(t)$ in order for the Total Cases function $c(t)$ to become horizontal?

6. What is the value of $d(t)$ as of yesterday? How close is it to $0$?