Crosscutting Concept: Cause and Effect

The purpose of this video is to introduce students to the concept of cause and effect and how to separate it from correlation. It is a resource to work directly with a Crosscutting Concept identified in the Next Generation Science Standards (NGSS). Understanding how a working scientist uses the lens of cause and effect to frame their research will prepare students to consider the role of cause and effect in their own science experiences.
This video can be accessed at: https://www.youtube.com/watch?v=zdpYZHCRCPE

Expected Outcomes: After working with this video, students will understand the difference between correlation and cause and effect. They will be ready to start identifying cause and effect in their science experiences, and understand why it is helpful to do so.

Guide:

1. Before watching the video, gather students' initial ideas about cause and effect. How can scientists figure out what is a cause of an observation, or what the effects of an observation might be? How can they tell if one observation is causing another?

2. Explain that we will watch a video about a scientist who is studying the cause and effect relationship between aging and disease. Explain that you will watch the video all the way through, and then watch it again to focus on specific parts

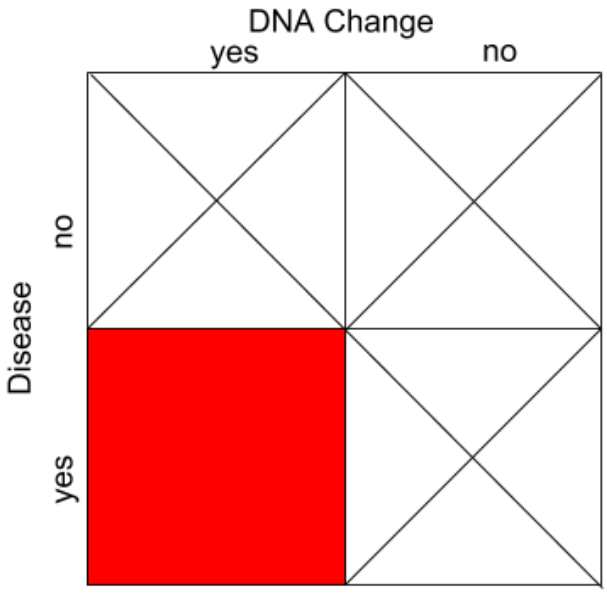
3. Watch the video all the way through.

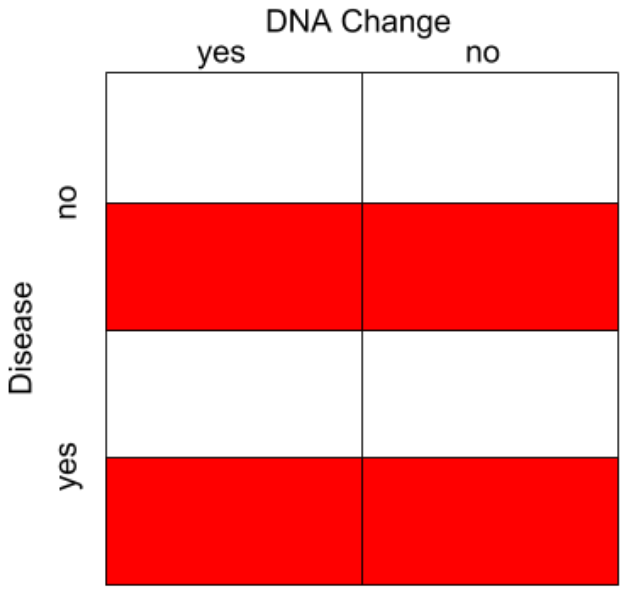
4. Lead a brief discussion with students to clarify the purpose of Megumi's research: She wants to understand how aging causes problems with the nervous system, as well as understand how activity in the nervous system can cause aging.

5. Watch the video again. Pause the video at 2:00 and lead a brief discussion about correlation and causation. Provide some examples (ideas below) of each and ask students whether the observations represent a cause and effect relationship, or just a correlation

a. When we observe the number of cars in a city increase, we also observe an increase in the number of buildings (correlation: cars don't cause buildings or vice versa; they are both caused by more people moving into a city).
b. Scientists observe that the more acorns a squirrel eats, the higher its body mass (causation: eating acorns causes higher body mass)
c. Stores observe that the number of sandals sold decreases as the number of umbrellas sold increases (correlation: they are both caused by changes in the weather)

6. Pause the video again at 3:18. Draw the following two images on the board and ask students which one represents Huntington's Disease (left), and which represents Alzheimer's (right). Why can we say that there is a cause and effect relationship between genetic information and the disease for Huntington's, but not for Alzheimer's?





7. Finish watching the video all the way through. Debrief by discussing with students why it might be important to understand both how aging causes diseases/changes in the nervous system, as well as how changes in the nervous system might cause aging in the rest of the body. How does thinking about cause and effect help Megumi ask new questions in her research?

Background Information on Cause and Effect

Probing for a cause and effect relationship is an important task in scientific endeavors. Many investigations begin with an observation of some type of correlative pattern, either positive (two things increase together), or negative (one thing increases while another decreases). An important aspect of understanding how or why there is a correlation is understanding whether one observation is *causing* the other. It is important to test these relationships experimentally. Does one observation or change always precede the other (e.g. pedaling faster on a bike leading to higher velocity)? Are there multiple causes that can lead to the same effect (e.g. both lifestyle choices and genetic predisposition can lead to heart attacks)?

Cause and effect can become complex in natural systems. The cyclical pattern observed in some predator-prey population dynamics is an example in which the population size of each group is both a cause *and* an effect: increasing numbers of predators causes a drop in the prey population. This decrease in the prey population then causes a decrease in the predator population. This decrease in the predator population then causes an increase in the prey population, which in turn causes an increase in the prey population, and the cycle repeats again.

Follow up: Give students time and explicit guidance to reflect on their classroom investigations and phenomena using the lens of cause and effect. This is particularly useful when planning an investigation based on an observation, because clarifying a cause and effect relationship creates a framework for the variables under consideration. It is also helpful when writing an explanation or argument that uses evidence, because cause and effect are two anchor points that the piece of writing can be centered around.

The following questions can be helpful to guide students in their thinking:

1. Do I observe a relationship between two things?
2. If I change one thing/variable, does it lead to a different change? Is this repeatable?
3. Are there different ways to make the same change happen?