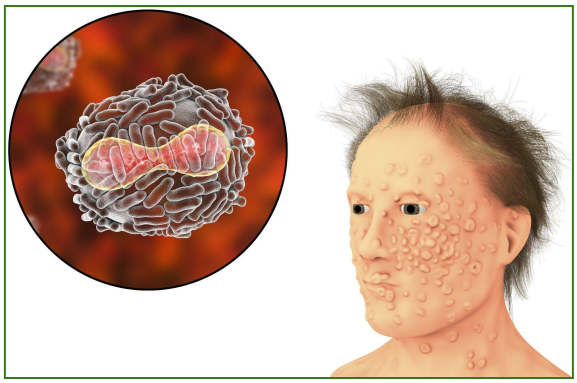
Ready For More Scientific Thinking? U-1 L-3

Exploring Science / Historical Steps

Scientific Thinking And Vaccines In the last lesson you learned the basic steps of the scientific method and CER. To learn a few more parts of scientific thinking, let's look at the work of another famous scientist from the past.

Edward Jenner - famous for his smallpox vaccine

In the late 1700s, no one knew that many diseases were caused by things too small to be seen. Sadly, the virus causing **smallpox** was killing millions of people. This disease caused pus-filled blisters to form on its victims.



The virus that causes smallpox **A man with smallpox blisters**

#1 - RECOGNIZING PATTERNS

A pattern is a repeated observation - something that is seen, heard, smelled, touched or tasted more than once.

Milkmaids, young women who milked cows, often suffered from *cowpox.* This disease seemed much like smallpox. It caused illness and pus-filled blisters. But cowpox did not kill people.

Edward Jenner, a surgeon in England, noticed a puzzling pattern. Even when smallpox was killing people all around them, milkmaids were not dying.

#2 - INFERRING

To infer is to make a guess, judgment, or conclusion based on observations or data.

In 1796, Jenner made an inference. Maybe something in the pus of cowpox blisters protects milkmaids from whatever causes smallpox. He decided to try an experiment.

#3 - EXPERIMENTING

Use of the scientific method
[See the previous lesson.]

From the blister of a milkmaid with *cowpox*, Jenner removed a small amount of pus. He put this pus under the skin of a healthy child! The child was ill for nine days, and then recovered. Jenner then put pus from someone's *smallpox* blister under the same child's skin. As Jenner expected, no disease occurred!

#4 - COMPARING, OR CONTROLLING

Some experiments are simply comparisons. Others involve controls - which are described next.

Jenner *compared* the child that he helped to children who were not given the cowpox pus. Sadly, many children who were not given the cowpox pus died.

Later, Jenner compared more people who were given the cowpox pus to people who did not receive it. Over and over, people who were given the cowpox pus did not die from smallpox. And over and over, many people who never received the cowpox pus died of smallpox.

Today's scientists would complete Jenner's experiment a bit differently. First, they would put the cowpox pus under the skin of a large number of volunteers. Then, under the skin of a *second* large group of very similar volunteers, they would put clean water (instead of pus). Both groups would then be observed.

The second group is called the **control** group. Using this method, called a **controlled experiment**, scientists would know for sure that any difference between the groups was due to the cowpox pus.

#5 - AVOIDING BIASES

A bias is simply an opinion based on past experiences.

Jenner was criticized by many people. This often happens to those who try something new. People in Jenner's time simply could not imagine how Jenner's cowpox pus could work. Their biases kept them from believing his claim. Even the most famous group of scientists, the **Royal Society** (in England), refused to publish Jenner's results.

Fortunately, within a few years, Jenner's method was accepted and widely used. A disease that had killed millions of people was gradually defeated.

The fact is, we all have biases. Scientists must ignore their biases in order to design experiments, and draw conclusions.

#6 - VERIFYING

To verify is to repeat work and obtain the same outcome.

Many important discoveries have occurred because scientists noticed a *pattern*, made an *inference*, and then designed a *controlled experiment* that was free of *bias*.

To be widely accepted, the results of an experiment must be able to be verified (VARE-uh-fide). That is, another scientist must be able to repeat the experiment - and obtain the same results. Of course, for verification to occur, all of the steps of an experiment must be very clearly described. Good scientists must also be good writers!

➤ You probably know that Jenner's method is known today as **vaccination**. Of course, today's vaccines use products that are much safer than pus. (Vaccines are covered in more detail in Unit 10, Lesson 2, page 274).

➤ Want more? Research malaria.

In 2021, malaria killed nearly a half million people - mostly infants and children living in Africa. In the Spring of 2022, scientists at The Jenner Institute in Oxford, England, announced that they had developed an effective vaccine against this horrible disease!

Six parts of scientific thinking...

- **Recognizing Patterns**
- **Inferring**
- **Experimenting**
- **Comparing, or Controlling**
- **Avoiding Biases**
- **Verifying**

➢ To Do Yourself **Are you ready to use the six parts of scientific thinking?**

You will need: A notebook and a pencil. This activity is simply a way to practice *thinking* scientifically. You are not expected to do more than record your *thoughts*.

1. Walk down your street and use your observation skills to "wonder"!

2. Jot down what you see, hear, smell, and feel. (You probably don't want to taste anything at this point).

3. Write down any patterns that you notice. Are there some repeated images, sounds, smells or textures?

4. Does anything occur that leads you to guess "Why"? By guessing, you are inferring!

5. How might you find out if your inference is correct? Would you be able to learn the answer from more observations?
Or from a comparison?
Or from a controlled experiment?

6. Pause to ask yourself: Have experiences from my past influenced what I've recorded so far? Have my biases affected my thinking?

7. If you gather enough information to determine an answer to your question in step 4, ask yourself: If a friend wanted to repeat my work, what should I be sure to share so that she or he may verify my outcome?

Question:

• Which of your observations surprised you?_____

_____

---------- REVIEW ---------- U-1 L-3

I. Fill each blank with the word that fits best. Choose from the words below.

control **verify** **biases** **patterns** **infer** **compare**

We all have past experiences, so it is not surprising that we all have _____.

A careful observer is alert for things that repeat - called _____.

If you have observed someone's cheerful behavior carefully, and have noticed a pattern, you might _____why they smile so often. Among the volunteers in an experiment, some do not receive a treatment. This group is the _____.

II. In 2020, to develop vaccines against the COVID-19 virus, thousands of volunteers were divided into two very similar groups. One group did receive a vaccine. The other group (the control group) received clean water. Scientists kept track of how many people from each group became sick with COVID-19.

• An experiment with a control group allows a scientist to feel more confident about her conclusion. Explain why this is the case.