

## Questions about the Graph:

Name/lab time: \_\_\_\_\_

1. How does the first part of the graph (days 0-28) compare to the second part of the graph (days 28-60)?

*Antibody production is higher during the second exposure on days 40-60 compared to the first exposure on days 0-28.*

2. Which do you think is the response being made by the memory cells?

*The response on days 40-60. The body produced memory cells during the first exposure so it is ready to fight off the antigen more efficiently the second time.*

3. State a precise definition of a vaccine and include in your definition the term primary immune response.

*A vaccine is a controlled exposure to an antigen. The exposure can be controlled by weakening or killing the antigen. Anything with the same structure as the antigen can be used as long as it triggers the production of antibodies without causing a severe infection.*

*The first exposure to an antigen that causes the body to produce antibodies is called the primary immune response (PMI). During the PMI memory cells are also created so that the body can recognize and respond quickly when exposed to the same antigen in the future.*

*So in effect, a vaccine is a controlled way of activating a person's PMI to a specific antigen so that the person will produce memory cells to protect them from the antigen in the future.*

In 2003, a nasal-spray flu vaccine was licensed for use and now gives patients a choice other than the typical flu shot. This nasal-spray vaccine contains three different types of live viruses that are attenuated, cold-adapted, and temperature sensitive. Attenuated means the viruses are weakened and will not cause severe symptoms of influenza. Cold-adapted and temperature sensitive mean the viruses can grow inside the nose and throat, but not in the lungs where the temperature is higher. Based on your knowledge of immunity, how does this vaccine work?

*This vaccine works by weakening the viruses prior to use and by altering the viruses so that they can survive in a person's nose and throat but not in their lungs. This temperature adaptation of the viruses ensures that the person does not get a severe infection from the vaccine. Since the viruses can survive in the nose and throat they will trigger the PMI causing the person to produce memory cells that will protect them in the future.*

2. Read historical documents and respond to the questions found on the data collection sheet. Notice that the left side of the data sheet corresponds to the letter from Lady Montague and the right side to that of the journal entries of Edward Jenner.

### Historical Documents Data Collection

Letter from Lady Montague, 1717	Journal Entries of Edward Jenner, 1796
<p><b>Note:</b> Smallpox is a very contagious virus that causes sores or “pox” on the skin. During the 1700’s, when this letter was written many died of smallpox, particularly children</p>	<p><b>Background:</b> Edward Jenner was an English physician who worked in small farming villages during the late 1700’s.</p>
<p>1. Describe the actions of the women in the market.</p> <p><i>The women offered to insert a form of smallpox that they had collected in a walnut shell under the subject’s skin in numerous places.</i></p>	<p>1. With what did Sarah Nelmes become infected? What in her daily routine exposed her to this pathogen?</p> <p><i>She was infected with cowpox through a scratch on her hand. Her work as a dairymaid made it likely for her to come in contact with the disease.</i></p>
<p>2. How often and when did they do this activity?</p> <p><i>They did this every autumn in September when the heat had abated.</i></p>	<p>2. What symptoms did Jenner note?</p> <p><i>She had a large puss filled sore on her hand where the cowpox had entered through her cut.</i></p>
<p>3. What specifically happened to the person who received this treatment?</p> <p><i>The person would get sick a few days later but it is not a fatal infection. They completely recover except for scars where they had received the smallpox under their skin.</i></p>	<p>3. What did Jenner do on May 14, 1796?</p> <p><i>He inserted material that he had taken from Sarah’s sore into a healthy eight year old boy’s arm.</i></p>
<p>4. Why would a person agree to have this treatment? Is there a benefit?</p> <p><i>Smallpox was often fatal so going through this procedure could save their life.</i></p>	<p>4. What did Jenner do on July 1, 1776?</p> <p><i>He inserted material that he had taken from smallpox sore into the same healthy eight year old boy’s arms.</i></p>
<p>5. Why do you think Lady Montague was so interested in the activity of the women in the marketplace?</p> <p><i>She had never seen any procedure such as this that could save someone from a fatal disease. She saw the potential for saving lives, starting with her son.</i></p>	<p>5. What hypothesis do you think Jenner made and then tested?</p> <p><i>He wanted to see if cowpox and smallpox were closely related enough to act as a vaccine. He hoped that if a person was exposed to and suffered the milder cowpox they would be protected from catching smallpox in the future.</i></p>

\*Adapted from Allison Granberry 2004: <http://www.scienceteacherprogram.org/biology/Granberry04.html>

## Letter from Lady Montague, 1717

*In 1717 Lady Montague arrived with her husband, the British ambassador, at the court of the Ottoman Empire (Modern day Turkey). She wrote much about her travels. The following is a letter that she sent to a friend back home in England.*

A propos of distempers, I am going to tell you a thing that will make you wish yourself here. The small-pox, so fatal, and so general amongst us, is here entirely harmless, by the invention of engrafting, which is the term they give it. There is a set of old women, who make it their business to perform the operation, every autumn, in the month of September, when the great heat is abated. People send to one another to know if any of their family has a mind to have the small-pox; they make parties for this purpose, and when they are met (commonly fifteen or sixteen together) the old woman comes with a nut-shell full of the matter of the best sort of small-pox, and asks what vein you please to have opened. She immediately rips open that you offer to her, with a large needle (which gives you no more pain than a common scratch) and puts into the vein as much matter as can lie upon the head of her needle, and after that, binds up the little wound with a hollow bit of shell, and in this manner opens four or five veins. The Grecians have commonly the superstition of opening one in the middle of the forehead, one in each arm, and one on the breast, to mark the sign of the Cross; but this has a very ill effect, all these wounds leaving little scars, and is not done by those that are not superstitious, who chuse to have them in the legs, or that part of the arm that is concealed. The children or young patients play together all the rest of the day, and are in perfect health to the eighth.

Then the fever begins to seize them, and they keep their beds two days, very seldom three. They have very rarely above twenty or thirty in their faces, which never mark, and in eight days time they are as well as before their illness. Where they are wounded, there remains running sores during the distemper, which I don't doubt is a great relief to it. Every year, thousands undergo this operation, and the French Ambassador says pleasantly, that they take the small-pox here by way of diversion, as they take the waters in other countries. There is no example of any one that has died in it, and you may believe I am well satisfied of the safety of this experiment, since I intend to try it on my dear little son. I am patriot enough to take the pains to bring this useful invention into fashion in England, and I should not fail to write to some of our doctors very particularly about it, if I knew any one of them that I thought had virtue enough to destroy such a considerable branch of their revenue, for the good of mankind. But that distemper is too beneficial to them, not to expose to all their resentment, the hardy wight that should undertake to put an end to it. Perhaps if I live to return, I may, however, have courage to war with them. Upon this occasion, admire the heroism in the heart of

*Your friend, etc. etc.*

### **Source:**

From Lady Mary Wortley Montague, *Letters of the Right Honourable Lady M--y W--y M--e: Written During her Travels in Europe, Asia and Africa. . .*, vol. 1 (Aix: Anthony Henricy, 1796), pp. 167-69; letter 36, to Mrs. S. C. from Adrianople, n.d.

## JOURNAL ENTRIES OF EDWARD JENNER, 1796

### CASE XVI

SARAH NELMES, a dairymaid at a Farmer's near this place, was infected with the Cow Pox from her master's cows in May, 1796. She received the infection on a part of the hand which had been previously in a slight degree injured by a scratch from a thorn. A large pustulous sore and the usual symptoms accompanying the disease were produced in consequence. The pustule was so expressive of the true character of the Cow Pox, as it commonly appears upon the hand, that I have given a representation of it in the annexed plate.

### CASE XVII

THE more accurately to observe the progress of the infection, I selected a healthy boy, about eight years old, for the purpose of inoculation for the Cow Pox. The matter was taken from a sore on the hand of a dairymaid, who was infected by her master's cows, and it was inserted, on the 14th of May, 1796, into the arm of the boy by means of two superficial incisions, barely penetrating the cutis, each about half an inch long.

...In order to ascertain whether the boy, after feeling so slight an affection of the system from the Cow-pox virus, was secure from the contagion of the Small-pox, he was inoculated the 1st of July following with variolous matter, immediately take from a pustule. Several slight punctures and incisions were made on both of his arms, and the matter was carefully inserted, but no disease followed. The same appearances were observable on the arms as we commonly see when a patient has had variolous matter applied, after having either the Cow-pox or the Small-pox. Several months afterwards, he was again inoculated with variolous matter, but no sensible effect was produced on the constitution.

...Thus far have I proceeded in an inquiry, founded, as it must appear, on the basis of experiment; in which, however, conjecture has been occasionally admitted in order to present to persons well situated for such discussions, objects for a more minute investigation. In the mean time I shall myself continue to prosecute this inquiry, encouraged by the hope of its becoming essentially beneficial to mankind.