

**Teacher’s Guide**

**Can a Vaccine End the Pandemic?**

***December 2020***

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Activate students’ prior knowledge and engage them before they read the article.

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These questions are designed to help students read the article (and graphics) carefully. They can help the teacher assess how well students understand the content and help direct the need for follow-up discussions and/or activities. You’ll find the questions ordered in increasing difficulty.

[Graphic Organizer 5](#_Graphic_Organizer)

Thishelps students locate and analyze information from the article. Students should use their own words and not copy entire sentences from the article. Encourage the use of bullet points.

[Answers 6](#_Answers_to_Reading)

Access the answers to reading comprehension questions and a rubric to assess the graphic organizer.

[Additional Resources 9](#_Additional_Resources_1)

Here you will find additional labs, simulations, lessons, and project ideas that you can use with your students alongside this article.

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# Anticipation Guide

Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Directions: *Before reading the article*,** in the first column, write “A” or “D,” indicating your **A**greement or **D**isagreement with each statement. Complete the activity in the box.

As you read, compare your opinions with information from the article. In the space under each statement, cite information from the article that supports or refutes your original ideas.

|  |  |  |
| --- | --- | --- |
| **Me** | **Text** | **Statement** |
|  |  | 1. Most infants receive a vaccine for hepatitis B shortly after birth. |
|  |  | 1. Smallpox was the first disease treated by vaccination. |
|  |  | 1. Your skin is part of your immune system. |
|  |  | 1. Vaccines introduce part of a whole virus to make your body produce antibodies specific for the virus. |
|  |  | 1. All vaccines work the same way. |
|  |  | 1. COVID-19 is the first viral disease that has kept children home. |
|  |  | 1. Vaccines may contain formaldehyde. |
|  |  | 1. Some multi-dose vaccines contain the same amount of mercury as that in a 3-oz can of tuna. |
|  |  | 1. Aluminum phosphate is added to some vaccines to prevent unwanted bacteria and fungi growth. |
|  |  | 1. Smallpox has been eradicated due to the use of vaccines. |

# Student Reading Comprehension Questions

Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Directions**: Use the article to answer the questions below.

1. What does a vaccine do for a person?
2. How did Dr. Edward Jenner’s method differ from what the Chinese doctors had been doing to try to help people fight off smallpox?
3. Which part of the immune system can be “trained” using vaccines?
4. Why does giving you the virus in the form of a vaccine help you fight off the virus that you might eventually be exposed to?
5. What is the difference between an antigen and an antibody?
6. Formaldehyde is a compound used as a preservative in funeral homes. Why are tiny amounts of this compound included in a vaccine?
7. The three major parts of the coronavirus are the viral envelope, which is made of proteins, the spike proteins that cover the viral envelope, and the RNA that is inside the viral envelope.
   1. Which part of the virus is responsible for the reproduction of more virus particles?
   2. Which part of the virus is responsible for getting it into a human cell?
8. Make an analogy for a virus and use it to describe each of the four main strategies used to produce vaccines. (You do not have to consider what it will do in the body, only how it relates to the virus itself.)

**Student Reading Comprehension Questions, cont.**

**Questions for Further Learning**

***Write your answers on another piece of paper if needed.***

1. Watch the video using the link at the end of the article.
   1. The virus responsible for the COVID-19 pandemic is in a class of viruses, called coronaviruses, that our bodies have had prior exposure to. Why does this help to speed the development of a vaccine for this most recent virus?
   2. At what point in your exposure to a virus are you considered to be infected?
   3. What is the role of the spike protein on the SARS CoV-2 virus?
   4. Why is knowledge of the specific structure and shape of the spike protein on a coronavirus important to scientists that are working on a vaccine for that virus?
2. Choose one of the four vaccine strategies and explain how putting that type of vaccine in your body is different from infecting the body with the virus you are trying to fight.
3. Consider the doctors that originally worked with the smallpox virus. Write an experimental question, along with a hypothesis, that may have guided:
   1. the Chinese doctors.
   2. the English doctor, Edward Jenner.

# Graphic Organizer

Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Directions**: As you read, complete the graphic organizer below to describe what you learned about vaccines.

|  |  |  |
| --- | --- | --- |
| 3 | **New things you learned about making vaccines** |  |
| 2 | **Additives that may be added to vaccines, and why they are needed** |  |
| 1 | **Question you have about vaccines** |  |
| Contact! | **How does an understanding of chemistry help you make decisions about your health?** |  |

# Answers to Reading Comprehension Questions & Graphic Organizer Rubric

1. **What does a vaccine do for a person?**

*A vaccine helps the immune system to fight off certain infections or diseases.*

1. **How did Dr. Edward Jenner’s method differ from what the Chinese doctors had been doing to try to help people fight off smallpox?**

*The Chinese doctors were using discharges from infected people to introduce the same virus into people as they were trying to prevent. Dr. Jenner used a similar, but not the same, virus and introduced it into people to see if it would stave off the intended virus.*

1. **Which part of the immune system can be “trained” using vaccines?**

*The adaptive immune system, because it is more specific to the foreign substances in the body and adapts to remove or fight them.*

1. **Why does giving you the virus in the form of a vaccine help you fight off the virus that you might eventually be exposed to?**

*It gives your body a chance to build up some immunity before you get infected, so it can fight it off faster.*

1. **What is the difference between an antigen and an antibody?**

*An antigen is a substance or molecule that triggers an immune response. An antibody is produced by the body in response to the antigen so it can recognize the antigen, bind to it, and prevent it from doing its damage.*

1. **Formaldehyde is a compound used as a preservative in funeral homes. Why are tiny amounts of this compound included in a vaccine?**

*Formaldehyde is a molecule which can inactivate a virus, making it unable to replicate.*

1. **Three major parts of the coronavirus are the viral envelope, which is made of proteins, the spike proteins that cover the viral envelope, and the RNA that is inside the viral envelope.**
   1. **Which part of the virus is responsible for the reproduction of more virus particles?**

*RNA. When the RNA is released into a human cell, the cell treats it like any other RNA and ends up replicating many more viruses that eventually burst out of the cell to go infect new cells.*

* 1. **Which part of the virus is responsible for getting it into a human cell?**

*The spike protein. It binds with a receptor molecule on the outside of a cell, allowing it to then merge with the lipid membrane and deliver its contents to the inside of the cell.*

1. **Make an analogy for a virus and use it to describe each of the four main strategies used to produce vaccines. (You do not have to consider what it will do in the body, only how it relates to the virus itself.)**

*Answers will vary. Look for understanding of how the vaccine component is different from the “live” virus.*

**Questions for Further Learning**

1. **Watch the video using the link at the end of the article:** [**bit.ly/Reactions-Vaccine**](https://www.acs.org/content/acs/en/pressroom/reactions/videos/2020/coronavirus-vaccine-where-are-we-and-whats-next.html)
   1. **The virus responsible for the COVID-19 pandemic is in a class of viruses, called coronaviruses, that our bodies have had prior exposure to. Why does this help to speed the development of a vaccine for this most recent virus?**

*Since our immune system has been exposed to similar types of molecules, it has already developed antibodies and a mechanism to fight it. Scientists do not have to start at the beginning of the process if they already know a lot about how the virus works and have already developed similar vaccines. The hope is that they can build on the framework of what has already been tested, thus saving a lot of time.*

* 1. **At what point in your exposure to a virus are you considered to be infected?**

*When the viral RNA has entered one of your cells.*

* 1. **What is the role of the spike protein on the SARS CoV-2 virus?**

*To find the receptor on the outside of the cell, starting the infection process.*

* 1. **Why is knowledge of the specific structure and shape of the spike protein on a coronavirus important to scientists that are working on a vaccine for that virus?**

*Understanding the structure can give scientists possible avenues for designing a vaccine molecule that prevents the spike protein from doing its job.*

1. **Choose one of the four vaccine strategies and explain how putting that type of vaccine in your body is different from infecting the body with the virus you are trying to fight.**

*Weakened: These are very similar to the actual virus, but scientists have found a way to modify the part of it that allows replication inside your cells. If it doesn’t make more viruses, it does not progress the infection.*

*Inactive: These are also very similar to the actual virus, but scientists have completely inactivated its ability to replicate, while keeping the parts that trigger the immune response.*

*Subunit: Sometimes a particular part of the virus is responsible for starting the infection process. In this case, it may be possible to use only that part of the virus, like a particular protein, rather than the full virus and RNA.*

*Piggyback: Use a known and harmless virus to inject RNA or DNA into the human cell in the same way as an infection, but the injected nucleic acid will contain the genetic code for a specific part of the virus. This is similar to the subunit strategy, but the molecule is made in the cell, rather than added to the vaccine.*

1. **Consider the doctors that originally worked with the smallpox virus. Write an experimental question, along with a hypothesis, that may have guided:**
2. **The Chinese doctors.**
3. **The English doctor, Edward Jenner.**

*Answers will vary. The difference will be that the Chinese doctors were using the exact virus, while Jenner was using a different one that was similar.*

**Graphic Organizer Rubric**

If you use the Graphic Organizer to evaluate student performance, you may want to develop a grading rubric such as the one below.

|  |  |  |
| --- | --- | --- |
| **Score** | **Description** | **Evidence** |
| 4 | Excellent | Complete; details provided; demonstrates deep understanding. |
| 3 | Good | Complete; few details provided; demonstrates some understanding. |
| 2 | Fair | Incomplete; few details provided; some misconceptions evident. |
| 1 | Poor | Very incomplete; no details provided; many misconceptions evident. |
| 0 | Not acceptable | So incomplete that no judgment can be made about student understanding |

# Additional Resources

**Labs and demos**

**Spreading Diseases:** In this activity, students model how a virus spreads through a group. Demonstration similar to the one found at the following website to show how easily a virus can be transmitted. There are many variants of this demonstration. Some use a gel that glows under black light to track where the gel shows up after some activity. Others like this one use a non-contact version where students have water in cups and use any chemical that changes pH to represent the virus. All cups are later tested with phenolphthalein. <https://www.sciencelearn.org.nz/resources/192-spreading-diseases>

**Simulations**

**“Solve the Outbreak” CDC Interactive Game:** Get clues, analyze data, solve the scenario, and save lives! In this app, you get to be the Disease Detective.<https://www.cdc.gov/mobile/applications/sto/web-app.html>

**Lessons and lesson plans**

**“The Vaccine Makers Project” Full lesson plans:** Find 12 complete lesson plans covering the human immune system, disease and vaccination, biomedical research and animals, and how diseases spread. <https://vaccinemakers.org/lessons>

**Projects and extension activities**

Research one of the prior pandemics and describe the progression of the pandemic and how it finally ended.

Play a card game called “VaxCards”. <http://www.vaxcards.com/rules>

The following description from the website explains why this should not be a touch subject.

* + This game was created by doctors for a few simple reasons.
    - To educate kids and parents about vaccination and infectious diseases
    - To provide a fun way to achieve this education, and
    - To provide a reward for vaccination that kids want!
  + Vaccination should not be a touchy subject, and we hope this game will start the conversation for those who are hesitant and make the process easier for parents and children to get educated about the diseases vaccines protect us from.

# Chemistry Concepts, Standards, and Teaching Strategies

**Connections to Chemistry Concepts**

The following chemistry concepts are highlighted in this article:

* Molecules & Bonding: Molecular structure

**Correlations to Next Generation Science Standards**

This article relates to the following performance expectations and dimensions of the NGSS:

**HS-ETS1-3**

Evaluate a solution to a complex real-world problem based on prioritized criteria and tradeoffs that account for a range of constraint, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

**Disciplinary Core Ideas:**

* ETS1.C: Optimizing the Design Solution

**Crosscutting Concepts:**

* Cause and Effect: Mechanism and explanation
* Structure and Function

**Science and Engineering Practices:**

* Constructing explanations (for science) and designing solutions (for engineering)
* Obtaining, evaluating, and communicating information

**Nature of Science:**

* Scientific knowledge assumes an order and consistency in natural systems.

**Correlations to Common Core State Standards**

See how *ChemMatters* correlates to the[Common Core State Standards](https://www.acs.org/content/acs/en/education/resources/highschool/chemmatters/teachers-guide.html) at www.acs.org/chemmatters.

**Teaching Strategies**

Consider the following tips and strategies for incorporating this article into your classroom:

* **Alternative to Anticipation Guide:** Before reading, ask students if how they think a vaccine against COVID-19 might work, and what might be in it.
* As they read, students can find information to confirm or refute their original ideas.
* After they read, ask students what they learned about how vaccines are developed.
* An excellent video (about 5 minutes long) that complements the information in the article is the ACS Reactions video: “Could a mRNA Vaccine End the Pandemic?” (also link on p. 18) <https://youtu.be/gDY8pH6OWBc> . This could be shown before or after reading the article.