



Vaccine Investigators: A Teen Health WeekSM 2020 Lesson



Special thanks to:

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Learning Objectives:

Students participating in this lesson will learn to...

- ...briefly explain how vaccines work
- ...identify vaccine-preventable diseases
- ...use research and critical thinking to identify facts and misconceptions about vaccines

Lesson Duration: 45-60 minutes

Target Age Group: 13-18 years of age (Middle School/High School)

Educational Standards:

This lesson can be used to fulfil the following educational standards:

National Health Education Standards

(<https://www.cdc.gov/healthyschools/sher/standards/index.htm>)

- 1.12.5: Propose ways to reduce or prevent injuries and health problems.

Pennsylvania Academic Standards for Health, Safety, and Physical Education

- 10.2.9.A: Identify and describe health care products and services that impact adolescent health practices.

- 10.2.9.C: Analyze media health and safety messages and describe their impact on personal health and safety.
- 10.2.9.D: Analyze and apply a decision-making process to adolescent health and safety issues.
- 10.2.12.A: Evaluate health care products and services that impact adult health

Common Core English Language Arts Standards (<http://www.corestandards.org/ELA-Literacy/>)

- **CC.1.2.D (9-12):** Evaluate author’s credentials and background to determine point of view or purpose.
- **CC.1.2.G (9-12):** Evaluate information found in multiple sources and mediums to address a question or solve a problem.
- **CC.1.2.G (9-12):** Analyze information found in different mediums.
- **CC.1.2.H (9-12):** Analyze texts for information based upon purposes and arguments for credibility, relevance, bias, accuracy and currency.
- **CC.1.2.H (9-12):** Analyze and assess information to extract valid and relevant ideas based on credibility, relevance, bias, accuracy and currency.

Class Preparation:

- Prior to class, print out the student handouts from the “Supplemental Materials.”
- Print one copy of each vaccine statement, putting successive pairs of statements together (#1 and #2, #3 and #4, etc.).
- Print out five copies of the “Evaluating Internet Resources,” and put one for each pair of vaccine statements.

Key Terms:

- **Antibodies:** Special proteins designed to fight specific pathogens.
- **Antigen:** Special proteins created by pathogens that trigger an immune system response.
- **Herd Immunity:** A concept where people who cannot receive a vaccine are protected if enough members of their community are vaccinated.
- **Pathogen:** Microorganisms that cause disease.
- **Vaccine:** A weakened or dead version of a specific disease designed to help the immune system protect against that disease

Lesson Overview:

Part One: A Basic Overview of Vaccines

How do vaccines work?

A **vaccine** is a weakened or dead version of a specific disease designed to help your immune system protect against that disease.

Your immune system is your body’s defense against **pathogens**, microorganisms such as viruses and bacteria that cause disease. Pathogens contain special molecules called antigens that trigger your immune system. When the immune system identifies an **antigen**, the body produces special proteins called **antibodies** that are specifically designed to combat specific infections.

Vaccines act as a “practice run” for your immune system. They trigger a body’s immune system by exposing a person to a weakened form of a pathogen and fostering the creation of antibodies. These antibodies fight the infection and remain in the body, prepared to combat future infections of that specific pathogen. <https://www.historyofvaccines.org/content/how-vaccines-work>

Vaccines don’t cure a disease; rather they help prevent or a person’s risk of infection.

Types of vaccine preventable diseases:

Ask the class to name any vaccine-preventable diseases they know. List them on the board.

Not all diseases are vaccine preventable. According to the Centers for Disease Control and Prevention, there are vaccines available for the following diseases (<https://www.cdc.gov/vaccines/vpd/vaccines-diseases.html>):

Adenovirus	Influenza	Rubella (German Measles)
Anthrax	Japanese Encephalitis	Shingles (Herpes Zoster)
Chickenpox	Measles	Smallpox
Cholera	Meningococcal Disease (Meningitis)	Tetanus (Lockjaw)
Diphtheria	Mumps	Tuberculosis
Hepatitis A	Pertussis (Whooping Cough)	Typhoid
Hepatitis B	Pneumococcal Disease	Varicella (chickenpox)
<i>Haemophilus influenzae</i> type b (Hib)	Polio (Poliomyelitis)	Yellow Fever
Human Papillomavirus (HPV)	Rabies	

Part Two: Vaccine Investigators

The internet has given rise to many myths and misconceptions about vaccines. Over the course of this class, students will work together to help separate vaccine fact from fiction.

1. Break the class into small groups.
2. Hand each group of them a pair of fact sheets (see handouts). One of the fact sheets has a true statement about vaccines while the other is a vaccine related myth. Also hand out a copy of the checklist for evaluating the credibility of internet sources.
3. For the next 15-20 minutes of class (time will vary based on class needs), have them conduct online research to identify which statement is a fact and which is a myth. Have them use their phones, iPads, laptops, or any available web-based technology.
4. Pass a copy of the fact sheet for evaluating internet sources, and remind them to make sure they are using credible internet sources, using the sheet (see Supplemental Materials) to help them distinguish reliable sources from unreliable ones.

Recommended starting points for vaccine research:

- History of Vaccines, (historyofvaccines.org)
- “Health Topics: Vaccines,” World Health Organization, (who.int/topics/vaccines/en)

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- “Vaccines,” Snopes, (snopes.com/?s=vaccines)
 - *Vaccines.gov: Your Best Shot at Good Health* (vaccines.gov)
 - “Vaccines and Immunizations,” Centers for Disease Control and Prevention, (cdc.gov/vaccines)
 - Vaccine Education Center, Children’s Hospital of Philadelphia (<https://www.chop.edu/centers-programs/vaccine-education-center>)
5. When they reach their conclusion, have fill out the handout sheet and provide factual information to back up their conclusion.
 6. Bring the class back together and go through each statement. Have the group that researched that statement explain whether it is a fact or myth, providing information they found during their research to support their conclusion. Teacher can consult the supplemental materials to verify or clarify their findings.

VACCINE FACTS	VACCINE MYTHS
Vaccines helped eradicate at least one deadly disease.	Vaccines cause autism.
Vaccines help prevent millions of deaths per year.	Vaccines cause dangerous, even deadly, side effects.
Vaccines help build herd immunity, which helps protect people who can’t get vaccines.	Too many vaccines weaken a person’s immune system.
Vaccines don’t 100% guarantee you won’t get sick.	You can get sick with the flu by getting a flu shot.
In order to reduce your flu risk, you need to get a flu shot every year.	Vaccines contain dangerous levels of thimerosal, a compound that contains mercury.

Part Three: Debrief

- Ask the students to share their thoughts on their research. Was there information they found surprising? Did their research change their opinions on vaccines?
- As an added activity, have the students devise ways of sharing their findings with their peers. Examples include creating a vaccine fact sheet tackling the vaccine facts and myths they researched or developing a social media campaign.

Supplemental Materials:

Student Materials:

- Vaccine Statements
- Evaluating Internet Resources (Source: Georgetown University Library)

Teacher Materials:

- Vaccine Statements Answers

STATEMENT #1: Vaccines helped eradicate at least one deadly disease.

(Circle One)

FACT

MYTH

Write your evidence in the space below:

List your sources below:

STATEMENT #2: Vaccines cause autism.

(Circle One)

FACT

MYTH

Write your evidence in the space below:

List your sources below:

STATEMENT #3: Vaccines help prevent millions of deaths per year.

(Circle One)

FACT

MYTH

Write your evidence in the space below:

List your sources below:

STATEMENT #4: Vaccines cause dangerous, even deadly, side effects.

(Circle One)

FACT

MYTH

Write your evidence in the space below:

List your sources below:

STATEMENT #5: Vaccines help build herd immunity, which helps protect people who can't get vaccines.

(Circle One)

FACT

MYTH

Write your evidence in the space below:

List your sources below:

**STATEMENT #6: Too many vaccines
weaken a person's immune system.**

(Circle One)

FACT

MYTH

Write your evidence in the space below:

List your sources below:

STATEMENT #7: Vaccines don't 100%
guarantee you won't get sick.

(Circle One)

FACT

MYTH

Write your evidence in the space below:

List your sources below:

STATEMENT #8: You can get sick with the flu by getting a flu shot.

(Circle One)

FACT

MYTH

Write your evidence in the space below:

List your sources below:

STATEMENT #9: In order to reduce your flu risk, you need to get a flu shot every year.

(Circle One)

FACT

MYTH

Write your evidence in the space below:

List your sources below:

STATEMENT #10: Vaccines contain dangerous levels of thimerosal, a compound that contains mercury.

(Circle One)

FACT

MYTH

Write your evidence in the space below:

List your sources below:

Evaluating Internet Resources

Source: Georgetown University Library

(<https://www.library.georgetown.edu/tutorials/research-guides/evaluating-internet-content>)

Unlike similar information found in newspapers or television broadcasts, information available on the Internet is not regulated for quality or accuracy; therefore, it is particularly important for the individual Internet user to evaluate the resource or information. Keep in mind that almost anyone can publish anything they wish on the Web. It is often difficult to determine authorship of Web sources, and even if the author is listed, he or she may not always represent him or herself honestly, or he or she may represent opinions as fact. The responsibility is on the user to evaluate resources effectively. Remember to evaluate Wikipedia articles too.

Ask yourself these questions before using resources from the World Wide Web:

Author

- Is the name of the author/creator on the page?
- Are his/her credentials listed (occupation, years of experience, position or education)?
- Is the author qualified to write on the given topic? Why?
- Is there contact information, such as an email address, somewhere on the page?
- Is there a link to a homepage?
- If there is a link to a homepage, is it for an individual or for an organization?
- If the author is with an organization, does it appear to support or sponsor the page?
- What does the domain name/URL reveal about the source of the information, if anything?
- If the owner is not identified, what can you tell about the origin of the site from the address?

Note: To find relevant information about the author, check personal homepages on the Web, campus directory entries and information retrieved through search engines. Also check print sources in the Library Reference area; Who's Who in America, Biography Index, and other biographical sources can be used to determine the author's credentials.

Purpose

Knowing the motive behind the page's creation can help you judge its content.

- Who is the intended audience?
- Scholarly audience or experts?
- General public or novices?

If not stated, what do you think is the purpose of the site? Is the purpose to:

- Inform or Teach?

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- Explain or Enlighten?
- Persuade?
- Sell a Product?

Objectivity

- Is the information covered fact, opinion, or propaganda?
- Is the author's point-of-view objective and impartial?
- Is the language free of emotion-rousing words and bias?
- Is the author affiliated with an organization?
- Does the author's affiliation with an institution or organization appear to bias the information?
- Does the content of the page have the official approval of the institution, organization, or company?

Accuracy

- Are the sources for factual information clearly listed so that the information can be verified?
- Is it clear who has the ultimate responsibility for the accuracy of the content of the material?
- Can you verify any of the information in independent sources or from your own knowledge?
- Has the information been reviewed or refereed?
- Is the information free of grammatical, spelling, or typographical errors?

Reliability and Credibility

- Why should anyone believe information from this site?
- Does the information appear to be valid and well-researched, or is it unsupported by evidence?
- Are quotes and other strong assertions backed by sources that you could check through other means?
- What institution (company, government, university, etc.) supports this information?
- If it is an institution, have you heard of it before? Can you find more information about it?
- Is there a non-Web equivalent of this material that would provide a way of verifying its legitimacy?

Currency

- If timeliness of the information is important, is it kept up-to-date?

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- Is there an indication of when the site was last updated?

Links

- Are links related to the topic and useful to the purpose of the site?
- Are links still current, or have they become dead ends?
- What kinds of sources are linked?
- Are the links evaluated or annotated in any way?

Note: The quality of Web pages linked to the original Web page may vary; therefore, you must always evaluate each Web site independently.

Conclusion

Be very critical of any information you find on the Web and carefully examine each site.

Web pages are susceptible to both accidental and deliberate alteration, and may move or disappear with no notice.

Print out or download all pages you plan to use in your research so that your bibliography will be complete and accurate.

Are you sure the Web is where you want to be? It may take an hour to find the answer to a question on the Web that would take a Reference Librarian two minutes to find. When in doubt, ask a Librarian!

Teacher Supplemental Materials:

#1: Vaccines helped eradicate at least one deadly disease.

FACT

Smallpox was a disease caused by the *variola* virus. It is characterized by a rash followed by disfiguring pustules. It was also a deadly disease, killing roughly 30% of people infected with it.

The World Health Organization began a series of smallpox eradication programs in the 1950s and 1960s. The Intensified Eradication Program, which began in 1967, involved comprehensive vaccine research, development, and distribution. This included improved monitoring of cases and mass vaccination campaigns. The World Health Assembly officially announced the eradication of smallpox on May 8, 1980. Smallpox is, so far, the only disease to be eradicated.

According to the World Health Organization, polio may be the next disease to be eradicated thanks to vaccines. Polio cases have not originated in the United States since 1979 and the last reported case of the disease in the U.S. was in 1993.

Sources:

- “Smallpox,” *History of Vaccines*, <https://www.historyofvaccines.org/content/articles/history-smallpox>.
- “Smallpox: History of Smallpox,” *Centers for Disease Control and Prevention*, <https://www.cdc.gov/smallpox/history/history.html>.
- “Global Health: Polio Elimination in the United States,” *Centers for Disease Control and Prevention*, <https://www.cdc.gov/polio/what-is-polio/polio-us.html>.

#2: Vaccines cause autism.

MYTH

The overwhelming scientific consensus is there is no link between vaccines and autism.

Assertions of the alleged link between vaccines and autism date back to a study conducted in the late 1990s led by British gastroenterologist (physician who specializes in the gastrointestinal tract) Andrew Wakefield. Wakefield argued there was a link between autism and the MMR (measles, mumps, and rubella) vaccine. His findings appeared in the February 28, 1998, edition of *The Lancet*, a prominent medical journal, where they received global attention.

However, despite exhaustive studies, no reputable members of the scientific community could verify Wakefield’s claims. They also found significant issues with his research. A 2011 report concluded Wakefield had falsified data and misrepresented the condition of his research subjects. With only 12 patients studied, the study’s sample size was very small and it had no control group.

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Moreover, it was eventually revealed that Wakefield had financial conflicts of interest. He held a patent on a vaccine that could have competed in the market with the MMR vaccine and he also had received money from lawyers who were preparing lawsuits against vaccine manufacturers. In 2010, *The Lancet* retracted the study after concluding it was a fraud.

Sources:

- Brian Deer, "How the Case Against the MMR Vaccine Was Fixed," *The BMJ* (January 6, 2011), <https://www.bmj.com/content/342/bmj.c5347>.
- "Do Vaccines Cause Autism?" *History of Vaccines*, <https://www.historyofvaccines.org/content/articles/do-vaccines-cause-autism>
- AJ Wakefield, "[RETRACTED]: Ileal-lymphoid-nodular hyperplasia, non-specific colitis, and pervasive developmental disorder in children," *The Lancet* 351, No. 9103 (February 28, 1998), [https://www.thelancet.com/journals/lancet/article/PIIS0140-6736\(97\)11096-0/fulltext](https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(97)11096-0/fulltext).
- "Vaccines and Autism," *Children's Hospital of Philadelphia*, <https://www.chop.edu/centers-programs/vaccine-education-center/vaccines-and-other-conditions/vaccines-autism>.

#3: Vaccines help prevent millions of deaths per year.

FACT

Immunization helps prevent 2-3 million deaths worldwide. Vaccine preventable illnesses can cause serious complications, disability, and even death.

According to the Centers for Disease Control and Prevention, the 2019-20 seasonal influenza season resulted in 22-31 million cases and 12,000-30,000 deaths.

Polio (poliomyelitis) can lead to temporary or permanent neurological issues and even total paralysis.

HPV (human papillomavirus), a vaccine-preventable disease, is the leading cause of cervical cancer and can also lead to other forms of cancer. Approximately 4,000 people per year die from cervical cancer. Hepatitis B can lead to liver cancer.

Sources:

- "Global Immunization: World Disease Incidence," *Children's Hospital of Philadelphia*, <https://www.chop.edu/centers-programs/vaccine-education-center/global-immunization/diseases-and-vaccines-world-view>.
- "History of Polio (Poliomyelitis)," *History of Vaccines*, <https://www.historyofvaccines.org/content/articles/history-polio-poliomyelitis>.
- "Immunization," *World Health Organization*, <https://www.who.int/news-room/facts-in-pictures/detail/immunization>. "Influenza (Flu): Preliminary In-Season 2019-2020 Burden Estimates," *Centers for Disease Control and Prevention*, <https://www.cdc.gov/flu/about/burden/preliminary-in-season-estimates.htm>.

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- “Vaccine Information for Adults: Vaccine-Preventable Adult Diseases,” *Centers for Disease Control and Prevention*, <https://www.cdc.gov/vaccines/adults/vpd.html>.

#4: Vaccines cause dangerous, even deadly, side effects.

MYTH

Every form of medication has some form of side effects. However, the side effects of vaccines are generally mild. Common side effects include pain or swelling at the injection site, fatigue, mild fever, headache or joint aches, rashes, and chills. These symptoms, if they appear at all, go away after a few days. Vaccines can also cause fainting in some cases.

According to the U.S. Department of Health and Human Services, more severe side effects, such as allergic reactions, occur in 1-2 out of 1 million cases.

Sources:

- “Data & Statistics,” *Health Resources & Services Administration*, <https://www.hrsa.gov/sites/default/files/hrsa/vaccine-compensation/data/data-statistics-vicp.pdf>.
- “Top 20 Questions about Vaccination,” *History of Vaccines*, <https://www.historyofvaccines.org/content/articles/top-20-questions-about-vaccination#2>.
- “Vaccines & Immunizations: Possible Side Effects from Vaccines,” *Centers for Disease Control and Prevention*, <https://www.cdc.gov/vaccines/vac-gen/side-effects.htm>.
- “Vaccine Side Effects,” *Vaccines.gov*, https://www.vaccines.gov/basics/safety/side_effects.
- “Vaccine Side Effects and Adverse Events,” *History of Vaccines*, <https://www.historyofvaccines.org/content/articles/vaccine-side-effects-and-adverse-events>.

#5: Vaccines help build herd immunity, which helps protect people who can't get vaccines.

FACT

Contagious diseases, such as influenza, measles, and meningitis require close contact with healthy hosts in order to spread. However, immunizations reduce the number of people in a given area a disease can infect. The more people in a community who are vaccinated, the fewer people a given pathogen can infect. High immunization levels can also minimize the impact of diseases when they appear. This community protection through vaccination is known as herd immunity.

Herd immunity also benefits people who cannot receive certain vaccines, such as people with certain allergies and people with compromised immune systems.

By contrast, decreased herd immunity can lead to new outbreaks of disease. According to the Centers for Disease Control and Prevention, there were 1282 reported measles cases in the Version 1.0 (March 2020)

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United States in 2019. This was the highest number of such cases since 1992. The CDC attributes recent increases in measles cases to unvaccinated individuals.

Sources:

- Manish Sadarangani, “Herd Immunity: How Does it Work?” *Oxford Vaccine Group*, <https://www.ovg.ox.ac.uk/news/herd-immunity-how-does-it-work>.
- “Measles (Rubeola): Cases and Outbreaks,” *Centers for Disease Control and Prevention*, <https://www.cdc.gov/measles/cases-outbreaks.html>.
- “Vaccines Protect Your Community,” *Vaccines.gov*, <https://www.vaccines.gov/basics/work/protection>.

#6: Too many vaccines weaken a person’s immune system.

MYTH

There is no evidence to suggest that multiple vaccinations compromise a person’s immune system.

In fact, doctors frequently administer vaccines that cover several different diseases at once, such as the MMR (measles, mumps, and rubella), TDap (tetanus, diphtheria, and pertussis), and Hib-Hep B (*Haemophilus influenzae* type B and hepatitis B). These are known as combination (or conjugate) vaccines.

Children aged 0-2 years are vaccinated to help them develop the antigens necessary for their immune systems to fight infections. The Centers for Disease Control and Prevention recommends infants and toddlers receive vaccinations for fourteen diseases: measles, mumps, rubella, chickenpox, hepatitis A and B, diphtheria, tetanus, pertussis, Hib, polio, the flu, rotavirus, and pneumococcal disease.

Sources:

- “Global Vaccine Safety: Six Common Misconceptions About Immunization,” *World Health Organization*, https://www.who.int/vaccine_safety/initiative/detection/immunization_misconceptions/en/index6.html.
- “In the Journals: Too Many Vaccines?” *Children’s Hospital of Philadelphia*, <https://www.chop.edu/news/journals-too-many-vaccines>.
- “Vaccine Safety: Multiple Vaccines and the Immune System,” *Centers for Disease Control and Prevention*, <https://www.cdc.gov/vaccinesafety/concerns/multiple-vaccines-immunity.html>.

#7: Vaccines don’t 100% guarantee you won’t get sick.

FACT

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Efficacy levels also known as “vaccine effectiveness” (VE) depend on the type of vaccine and an individual’s immune system. According to the World Health Organization, childhood vaccinations are effective for 85-95% of people who receive them. According to the Centers for Disease Control and Prevention, the seasonal flu vaccine reduces a person’s flu risk by 40-60%.

Despite not guaranteeing 100% effectiveness, many vaccines have very high effectiveness in preventing infection. For those who complete their MMR (measles, mumps, and rubella) inoculation, 99.7% are immune to measles. Meanwhile, chickenpox VE rates vary from 85-95% for all infections from the virus to 100% for moderate to severe chickenpox strains.

For those where vaccines are less effective, high community vaccination rates and herd immunity play important parts in keeping them safe.

Sources:

- “Global Vaccine Safety: Six Common Misconceptions About Immunization,” *World Health Organization*, https://www.who.int/vaccine_safety/initiative/detection/immunization_misconceptions/en/ind ex2.html
- “Influenza (Flu): How Well Flu Vaccines Work,” *Centers for Disease Control and Prevention*, <https://www.cdc.gov/flu/vaccines-work/vaccineeffect.htm>.
- “Top 20 Questions about Vaccination,” *History of Vaccines* <https://www.historyofvaccines.org/content/articles/top-20-questions-about-vaccination#2>

#8: You can get sick with the flu by getting a flu shot.

MYTH

The flu virus used in flu vaccines cannot give you influenza. Flu vaccines are made from either a specific gene from a flu strain or a noninfectious “inactivated” virus. Common side effects associated with the flu shot are soreness or swelling near the injection site, headache, fever, nausea, or muscle aches. These side effects are mild and generally go away in a day or two.

Sources:

- “5 Myths About the Flu Vaccine,” *World Health Organization*, <https://www.who.int/influenza/spotlight/5-myths-about-the-flu-vaccine>.
- “Influenza (Flu): Misconceptions about Flu Vaccines,” *Centers for Disease Control and Prevention*, <https://www.cdc.gov/flu/prevent/misconceptions.htm>.
- “Influenza (Flu): Vaccine Safety Questions & Answers,” *Centers for Disease Control and Prevention*, <https://www.cdc.gov/flu/prevent/general.htm>.

#9: In order to reduce your flu risk, you need to get a flu shot every year.

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FACT

Influenza is constantly mutating and changing with many different strains. Every year, health organizations coordinate around the globe to identify the strains that will comprise that year's seasonal flu vaccine. Flu vaccines in the United States protect against four strains of flu viruses. These are called quadrivalent vaccines and they protect against two strains of influenza A (H1N1 and H3N2) and two influenza B viruses. There are also versions that protect against three types of flu viruses, known as trivalent vaccines.

Because the flu virus is constantly changing, it is strongly recommended you receive a flu shot every year. This helps reduce your risk of infection and helps protect those who can't get a flu shot, such as people with compromised immune systems, through herd immunity.

According to the Centers for Disease Control and Prevention, the seasonal flu vaccine reduces a person's flu risk by 40-60%.

Sources:

- "Influenza (Flu): How Well flu Vaccines Work," *Centers for Disease Control and Prevention*, <https://www.cdc.gov/flu/vaccines-work/vaccineeffect.htm>.
- "Influenza (Flu): Key Facts About Flu Vaccines," *Centers for Disease Control and Prevention*, <https://www.cdc.gov/flu/prevent/keyfacts.htm>.
- "Influenza (Flu): Selecting Viruses for the Seasonal Influenza Vaccine," *Centers for Disease Control and Prevention*, <https://www.cdc.gov/flu/prevent/vaccine-selection.htm>.

#10: Vaccines contain dangerous levels of thimerosal, a compound that contains mercury.

MYTH

Thimerosal is a mercury-containing preservative used to prevent microbial growth in certain types of vaccines. However, there are two different forms of mercury: ethylmercury and methylmercury. Ethylmercury is a byproduct formed when thimerosal breaks down in the body. It is used in vaccines in part because ethylmercury is quickly and easily broken down by the body. By contrast, methylmercury, a byproduct of mercury found in the environment can accumulate in the body and cause adverse health issues.

There is no evidence of adverse health effects from thimerosal in vaccines.

Moreover, its usage in vaccine production has declined in the United States in favor of other preservative compounds. Since 2001, no childhood vaccines produced, except for some versions of the flu vaccine, in the United States contain thimerosal.

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- “Thimerosal and Vaccines,” *FDA*, <https://www.fda.gov/vaccines-blood-biologics/safety-availability-biologics/thimerosal-and-vaccines>.
- “Understanding Thimerosal, Mercury, and Vaccine Safety,” *Centers for Disease Control and Prevention*, <https://www.cdc.gov/vaccines/hcp/conversations/downloads/vacsafe-thimerosal-color-office.pdf>.
- “Vaccine Ingredients—Thimerosal,” *Children’s Hospital of Philadelphia*, <https://www.chop.edu/centers-programs/vaccine-education-center/vaccine-ingredients/thimerosal>.
- “Vaccine Safety: Thimerosal in Vaccines,” *Centers for Disease Control and Prevention*, <https://www.cdc.gov/vaccinesafety/concerns/thimerosal/index.html>.