STO-138

# Pathogens, Antibodies, and Vaccines

## Teacher Information

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## Summary

How does the immune response protect against diseases caused by bacteria? Students model antigen-antibody interactions. They measure antibody levels to compare antibody levels following exposure to pathogens in unvaccinated and vaccinated children.

## Core Concepts

- The immune system is responsible both for recovering from and preventing disease.
- Antigens are foreign proteins on the surfaces of pathogens.
- White blood cells produce antibodies and form memory cells.
- Antibodies attach to and destroy cells bearing antigens.
- The interaction between antigens and antibodies is specific.
- With first exposure to an antigen, the immune response is usually too slow to keep people from getting sick.
- With second exposure to an antigen, the immune response is rapid enough to prevent the disease.
- Vaccinations are injections of antigens that trigger the production of memory cells and antibodies.

## Time Required

Three 40-minute class periods

## Kit contains

- 3 foam balls to model bacteria
- Jewels (3 different shapes) to model antigens
- Glue dots
- Straws, clay, and rubber bands to model antibodies
- *Immunizations and the DTP Vaccine* brochure
- *Pertussis Antibody Test Instructions*
- 4 Pertussis Antibody Test Strips
- 4 tubes of simulated plasma samples

## Teacher Provides

- Safety goggles
- Paper towels for clean up
- Colored pens/pencils (3 different colors)

**Warning: Choking Hazard**

This Science Take-Out kit contains small parts. Do not allow children under the age of seven to have access to any kit components.



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## Note

If your students are working in teams, consider making extra black and white copies of the ***Immunizations and the DTP Vaccine*** brochure.

## Additional Resources

The History of Vaccines website provides additional information and activities.
http://www.historyofvaccines.org

## Reusing *Pathogens, Antibodies, and Vaccine* kits

Kits may be refilled and reused. Allow approximately 15-30 minutes for refilling 10 student kits. Teachers will need to instruct students on how to handle clean-up and return of the re-usable kit materials. Students should disassemble models of pathogens and antibodies and return parts to the bag. For example, teachers might provide the following information for students:

| Discard | Return to kit |
|---|---|
| • Pertussis Antibody Test Strips | • 3 foam balls<br>• Jewels<br>• Straws, clay, and rubber bands<br>• Immunizations and the DTP Vaccine<br>• Pertussis Antibody Test Instructions<br>• 4 tubes of plasma<br>• "Immunizations and the DTP Vaccine" |

***** Note: Consider laminating printed parts of the kits that may be reused.

- Immunity brochure on diphtheria, tetanus, and pertussis and the DTP vaccine
- Instructions and color chart for Pertussis Antibody testing
- "Immunizations and the DTP Vaccine" brochure

Refills for *Pathogens, Antibodies, and Vaccines* kits are available at www.sciencetakeout.com. The **10 Kit Refill Pack** includes the following materials:

- Instructions and Quick Guide for refilling kits
- 20 ml of each "plasma" sample (Day 0, Day 10, Day 20, Day 30)
- 40 Pertussis Antibody Test Strips
- Glue dots
- 4 graduated transfer pipets (for refilling the microtubes)



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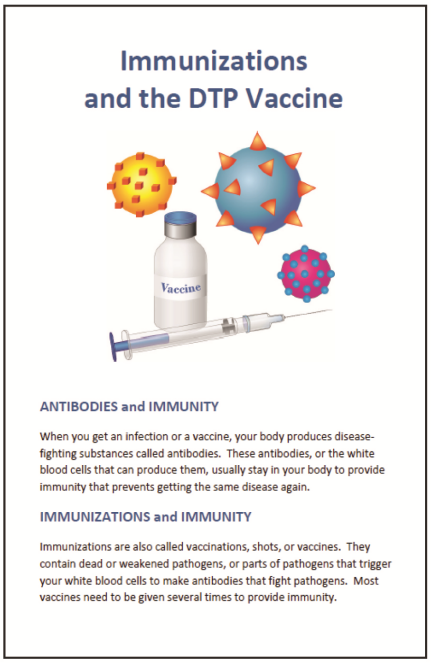
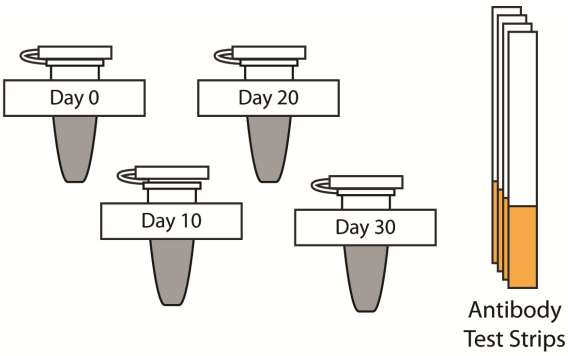
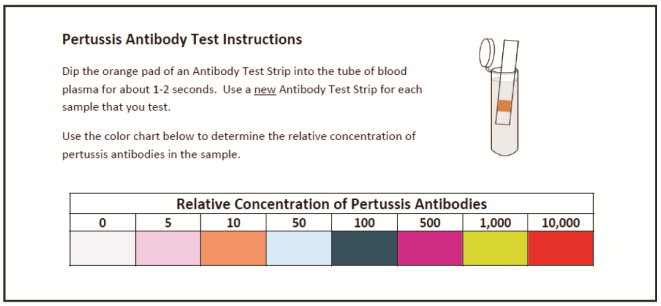
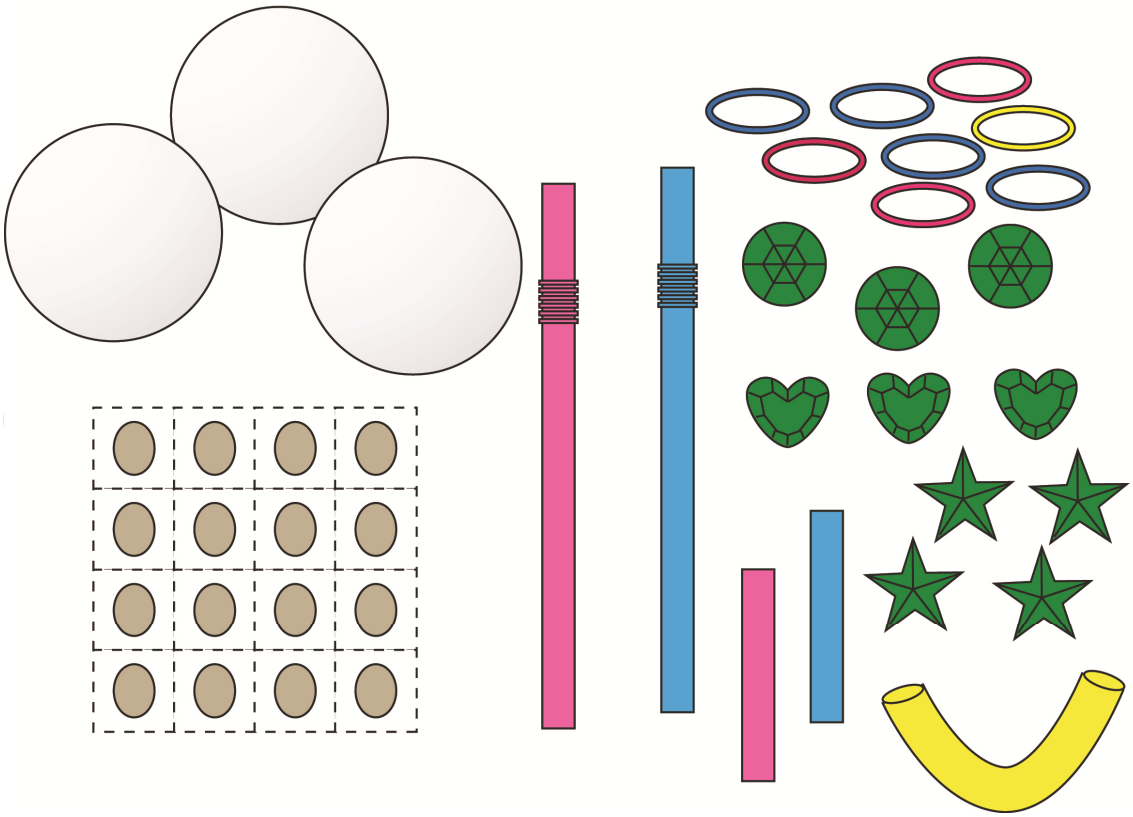
# Kit Contents Quick Guide





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# Read these instructions before using Science Take-Out kits

## Parental or Adult Supervision Required

This kit should be used only under the supervision of an adult who is committed to ensuring that the safety precautions below, and in the specific laboratory activity, are followed.

## Safety Goggles and Gloves Strongly Recommended

We encourage students to adopt safe lab practices, and wear safety goggles and gloves when performing laboratory activities involving chemicals. Safety goggles and gloves are not provided in Science Take-Out kits. They may be purchased from a local hardware store or pharmacy.

## Warning: Choking and Chemical Hazard

Science Take-Out kits contain small parts that could pose a choking hazard and chemicals that could be hazardous if ingested. Do not allow children under the age of seven to have access to any kit components. Material Safety Data Sheets (MSDS) provide specific safety information regarding the chemical contents of the kits. MSDS information for each kit is provided in the accompanying teacher instructions.

## Chemicals Used in Science Take-Out Kits

Every effort has been made to reduce the use of hazardous chemicals in Science Take-Out kits. Most kits contain common household chemicals or chemicals that pose little or no risk.

## General Safety Precautions

1. Work in a clean, uncluttered area. Cover the work area to protect the work surface.
2. Read and follow all instructions carefully.
3. Pay particular attention to following the specific safety precautions included in the kit activity instructions.
4. Goggles and gloves should be worn while performing experiments using chemicals.
5. Do not use the contents of this kit for any other purpose beyond those described in the kit instructions.
6. Do not leave experiment parts or kits where they could be used inappropriately by others.
7. Never taste or ingest any chemicals provided in the kit - they may be toxic.
8. Do not eat, drink, or apply make-up or contact lenses while performing experiments.
9. Wash your hands before and after performing experiments.
10. Chemicals used in Science Take-Out experiments may stain or damage skin, clothing or work surfaces. If spills occur, wash the area immediately and thoroughly.
11. At the end of the experiment, return ALL kit components to the kit plastic bag. Dispose of the plastic bag and contents in your regular household trash.

*No blood or body fluids from humans or animals are used in Science Take-Out kits. Chemical mixtures are substituted as simulations of these substances.*



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# Pathogens, Antibodies, and Vaccines - *Teacher Answer Key*

## Part 1: Modeling Pathogens and Antibodies

**Three dangerous diseases:**

- **Pertussis** (whooping cough) is caused by *Bordetella pertussis* bacteria
- **Diphtheria** is caused by *Corynebacterium diphtheria* bacteria
- **Tetanus** (lockjaw) is caused by *Clostridium tetani* bacteria

What happens when the body is invaded by the **pathogens** that cause these dangerous diseases?

**Pathogens** are disease causing microorganisms, such as bacteria, viruses, and fungi.

1. Use the information in the **"Immunizations and the DTP Vaccine"** brochure in your kit to complete the following chart.

| Disease | Pathogen (bacteria, viruses, or fungi) | Contagious (yes or no) | 3 Symptoms of disease | 2 Body systems affected | Probability of death if infected |
|---|---|---|---|---|---|
| **Diphtheria** | ***Bacteria*** | ***Yes*** | | | ___ in 10 |
| **Tetanus** lockjaw | ***Bacteria*** | ***No*** | | | ___ in 10 |
| **Pertussis** whooping cough | ***Bacteria*** | ***Yes*** | | | ___ in 10 |



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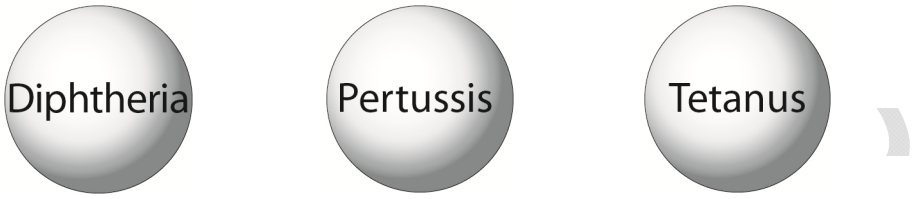
**Bacteria cause pertussis, tetanus, and diphtheria**

Pertussis, tetanus, and diphtheria are caused by pathogenic bacteria. You will use the materials in your kit to make models of these three bacteria.

2. The three foam balls represent **bacteria**. Use a pen or marker to label the balls—pertussis, tetanus, or diphtheria.




**Three Types of Bacteria**

3. The three types of bacteria have different **proteins** on their surfaces. The adhesive jewels represent surface proteins on the bacteria. Use the glue dots to firmly attach <u>three</u> of the same type of jewels to the surface of each of the bacteria. *Note: Save the extra star jewel (pertussis) for use later.*


**Three Types of Surface Proteins on Bacteria**

4. How are the bacteria that cause pertussis, tetanus, and diphtheria different?



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## Antigens

Humans do not make the proteins that are found on the surfaces of the bacteria that cause pertussis, tetanus, and diphtheria. So if these bacteria enter the human body, the bacterial proteins would be recognized as foreign proteins. A**ntigens** are foreign proteins that your body does not normally contain.

When your body recognizes an antigen, it triggers an immune response that will destroy the bacteria that have this antigen. During the **immune response**, white blood cells of your immune system produce **antibodies**. Antibodies are proteins made by your body that bind (attach) to and destroy bacteria.

5. What is an antigen?

6. Which parts of your models represent antigens?

7. What type of cells makes the immune response?

8. What molecules are produced during an immune response to destroy bacteria?

9. Your body cells have surface proteins. Why don't you make antibodies against these surface proteins?



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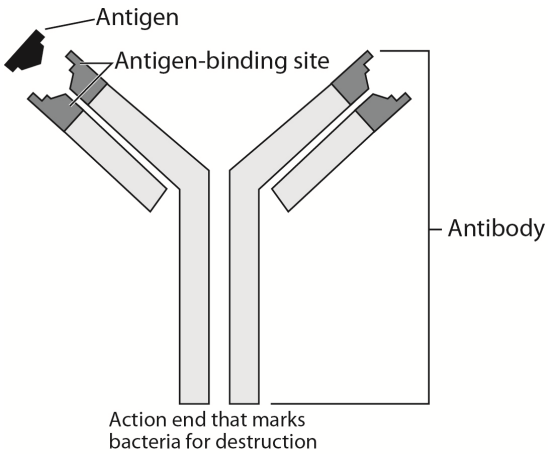
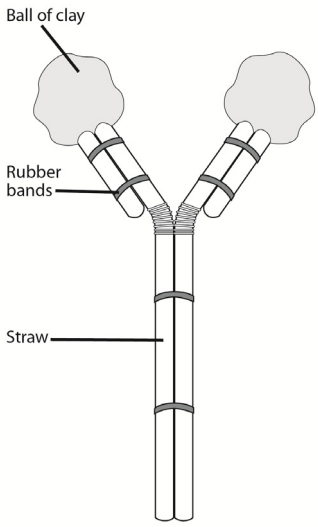
## Antibodies

During an immune response, white blood cells produce and release defensive proteins called **antibodies**. Each antibody molecule is a Y-shaped protein with two antigen binding sites on the ends. The antigen binding sites will bind to antigens on the surface of bacteria. The other end of the antibody is a "flag" that marks bacteria for destruction.




10. Use the four pieces of straw and small rubber bands to create a Y-shaped antibody molecule. Your model should look something like the diagram on the right.




11. Each antibody has two **antigen binding sites**. These specific antigen binding sites are **specific**. Specific means they have just the right shape to fit with <u>one</u> kind of antigen. You will make two antigen binding sites that can bind to the surface proteins (star jewels) on the bacteria that cause pertussis.

- Divide the strip of clay in half. Shape each half of clay into a ball.
- Make two pertussis antigen binding sites by pressing the star jewel (pertussis antigen) into the clay balls to make a pocket in the clay that will fit the pertussis antigen. Remove the star jewel to leave a pocket in the clay.
- Then, attach each of the balls of clay to the end of the straw. The pertussis antigen binding sites are on the ends of the Y shaped antibody, as shown in the drawing above. Make sure the star shaped pocket is facing out on the end of the antibody.
- Now you have a specific antibody that can bind to and destroy bacteria that cause pertussis.



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12. Attach your model of an antibody to one of the antigens on the surface of the bacteria cell that causes pertussis.

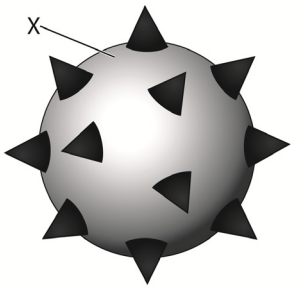
13. How can you tell that the antibody you made is **specific** for the bacteria that cause pertussis?

14. How would an antibody for diphtheria be different from an antibody for pertussis?

15. How would an antibody for pertussis be similar to an antibody for diphtheria?

16. What happens to bacteria cells when antibodies attach to antigens on the surface of the bacteria?

17. Will the antibody model that you made be able to protect against the Bacteria X shown on the right? Explain why or why not.




18. Words that start with the same letters are easy to confuse. Use your creativity to develop a way to help other students remember the difference between an **antigen** and an **antibody**.



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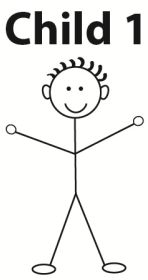
## Part 2: Antibodies and Immunity

In this activity, you will do laboratory tests to compare the antibody levels of three children (1, 2, and 3) who have been exposed to the bacteria that cause pertussis.




**Unvaccinated**
First exposure to bacteria that cause pertussis.

**Child 1: Unvaccinated First Exposure to Bacteria that Cause Pertussis**

The first time you are exposed to a specific pathogen, such as the bacteria that cause pertussis, the pathogens multiply causing you to get sick (have symptoms). You get sick because it takes about 10 to 15 days for the white blood cells to recognize the pathogen and divide to form many white blood cells that produce antibodies with the correct shape for fighting the specific pathogen.

The immune response that you make to the first exposure to a pathogen is called the **primary immune response.** It does not keep you from feeling sick but it does help you get better!

Once pathogens are destroyed, the concentration plasma cells and antibodies in the blood decreases but white blood cells called **memory cells** are left behind to fight that pathogen in the future.

1. A laboratory technician tested the antibody levels in **Child 1**'s plasma on the day of exposure to pertussis bacteria and 10, 20, and 30 days after the exposure. The results of these tests are shown in the data table below.

**Pertussis Antibodies in Child 1 Following Exposure to Bacteria that Cause Pertussis**

| | Relative Concentration of Pertussis Antibodies | | | |
|---|---|---|---|---|
| **Child** | **Day 0** | **Day 10** | **Day 20** | **Day 30** |
| **Child 1 Unvaccinated First Exposure** | **0** | **0** | **1000** | **100** |

2. Make a graph for the data from **Child 1**. Use the graph grid provided on the last page of this lab packet. *Indicate the color that you used to draw the line and circles in the key.*
   - You may tear this off to make it easier for you do the graph.
   - Include a title and appropriate labels for the axes.
   - Use circles and lines to plot the data for Child 1. *Indicate the color of the circle and lines you used in key.*



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3. Explain why **Child 1** gets sick and has the symptoms of pertussis. Support your explanation with information from the graph and the reading in the box.

4. What function do antibodies have for **Child 1**?

5. What does the primary immune response do the first time you are exposed to the bacteria that cause pertussis?

6. A doctor may prescribe an antibiotic if a person becomes sick with a disease. What is an antibiotic?

7. List three ways in which antibodies are more effective than antibiotics in protecting against pathogens.

**Antibodies** are specific proteins that your body produces in response to the presence of bacterial or viral antigens. They identify and attack invading bacteria or viruses. Specific antibodies can provide long-term immunity to specific diseases.

**Antibiotics** are nonspecific chemicals that temporarily reduce the duration and intensity of bacterial infections. They act by damaging the bacteria cell walls or disrupting the bacteria's metabolic processes. Antibiotics are not produced by the body and have no effect on viruses. Antibiotics may harm both pathogenic bacteria and beneficial (good) bacteria. Antibiotics also do not provide immunity to diseases.

8. Words that start with the same letters are sometimes easy to confuse. Use your creativity to develop a way to help other students remember the difference between an **antibody** and an **antibiotic**.



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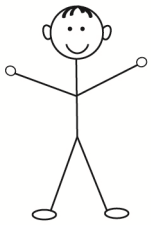
## Child 2



**Unvaccinated**
Second exposure to bacteria that cause pertussis.

### Child 2: Unvaccinated Second Exposure

If the same pathogen invades again, your immune system makes a more rapid response called the **secondary immune response**. The secondary immune response is a rapid response that can destroy pathogens before they have a chance to cause disease symptoms. This is possible because there are already many **memory cells** that recognize the pathogen and can quickly produce antibodies. As a result, the bacteria are destroyed before they make you feel sick.

One way to become immune to a disease is to be exposed to the pathogen that causes the disease and to get sick from it. Most people would not prefer this; they do not want to get sick and they do not want to risk dying from the disease.

9. A laboratory technician tested the antibody levels in **Child 2's** plasma on the day of exposure to pertussis bacteria and 10, 20, and 30 days after the exposure. The results of these tests are shown in the data table below.

**Pertussis Antibodies in Child 2 Following Exposure to Bacteria that Cause Pertussis**

| | Relative Concentration of Pertussis Antibodies | | | |
|---|---|---|---|---|
| **Child** | **Day 0** | **Day 10** | **Day 20** | **Day 30** |
| **Child 2 Unvaccinated Second Exposure** | **10** | **1000** | **1000** | **100** |

10. Add the data for **Child 2** to your graph. *Use a different colored line and triangles to plot this line and indicate the color you used in the key.*

11. What does it mean to say that someone is immune to the bacteria that cause pertussis?



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12. Explain why **Child 2** is immune to pertussis. Support your explanation with information from the graph and the reading.

13. How is the secondary immune response different from the primary immune response?

14. What are "memory" cells?

15. What is a disadvantage to developing immunity by being exposed to the bacteria that cause a pertussis?

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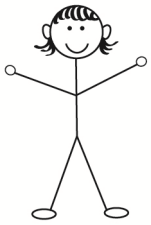
## Child 3



**Vaccinated**
Exposure to bacteria that cause pertussis.

### Child 3: Vaccinated before exposed to pertussis

To develop immunity to a pathogen without getting sick, you can be **vaccinated**—get an injection of a vaccine. A vaccine contains dead or weakened pathogens or antigens from the pathogen.

A vaccination will trigger an immune response in your body. After a vaccination, your body will make white blood cells called **memory cells** that recognize the pathogen or antigen and can rapidly make antibodies to destroy the pathogen. This means that if you are ever exposed to that same pathogen again, you will be immune and you will not get sick.

16. You will conduct the laboratory tests to determine the antibody levels in **Child 3**. Use the plasma sample from Child 3 and the Pertussis Antibody Test Instructions in your kit to complete the following data table.

**Pertussis Antibodies in Child 3 Following Exposure to Bacteria that Cause Pertussis**

| | Relative Concentration of Pertussis Antibodies | | | |
|---|---|---|---|---|
| **Child** | **Day 0** | **Day 10** | **Day 20** | **Day 30** |
| **Child 3 Vaccinated Exposure to bacteria that cause pertussis** | | | | |

17. Add the data for **Child 3** on your graph. *Use a different colored line and squares to plot this line and indicate the color you used in the key.*

18. Use the information in the box above and the graph to explain why Child 3 is immune to pertussis.



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19. What would be in a pertussis vaccine?

20. To reduce the number of vaccinations you need to receive, doctors typically use a vaccine called **DTP** that prevents diphtheria, tetanus, and pertussis. What would be in a DTP vaccine?

21. Will the DTP vaccine protect a person from other diseases such as measles, mumps, and chicken pox? Explain why or why not.

22. Which is the best way to prevent diseases like pertussis, tetanus, and diphtheria—getting an antibiotic or getting a DTP vaccination? Explain your answer.

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## Part 3: A Case of Pertussis (Whooping Cough)

### Colin's Story

Colin was an adorable and happy baby, but at three months of age he began coughing uncontrollably for long periods of time. Colin would cough so severely that his lips would turn blue and he would gasp for air.

Mary Wright, Colin's mother, rushed Colin to the emergency room, where he was immediately admitted and diagnosed with pertussis. Colin spent almost a month in the hospital. He required a breathing tube and he was given large doses of antibiotics. Mary felt very lucky that Colin survived.

Unfortunately, baby Colin was not the only one infected with the pertussis bacteria. A five-year old child in his neighborhood died from pertussis. Several high school students, including Colin's babysitter, also developed pertussis. There was even an outbreak of pertussis in a local nursing home where Colin's grandfather lived.

The one DTP vaccination that Colin had received when he was two months old was not enough to protect him against pertussis. It takes four DTP vaccinations to provide complete protection.

The DTP vaccine is used to prevent three dangerous diseases: diphtheria, tetanus, and pertussis.

Today, Mary Wright is back in school pursuing a degree in Public Health. She hopes to use her education to speak out about the dangers of contagious diseases and the importance of vaccinations, not just for babies, but also for all community members. She wants people to understand that infants who have not received all four of their DTP vaccinations are vulnerable to pertussis. They can be exposed to pertussis by people who are unvaccinated or who have not received the recommended teen and adult pertussis vaccine boosters.

**Use the information in Colin's Story to answer questions 1 and 2.**

1. Who might have exposed Colin to the bacteria that cause pertussis?

2. What actions could Mary have taken to prevent Colin's case of pertussis?



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**Use the information in the "Immunizations and the DTP Vaccine" brochure in your lab kit to answer questions 3-6.**

3. What substances in the DTP vaccine are important to preventing diphtheria, tetanus, and pertussis?

4. Why might some parents be concerned about having their children receive the DTP vaccine?

5. List two facts that could be used to convince parents that their children should receive the recommended DTP vaccinations.

6. Make a list of at least three actions that community members could take to prevent outbreaks of pertussis or other contagious diseases.

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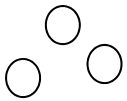
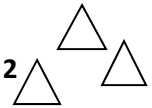
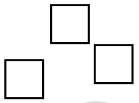
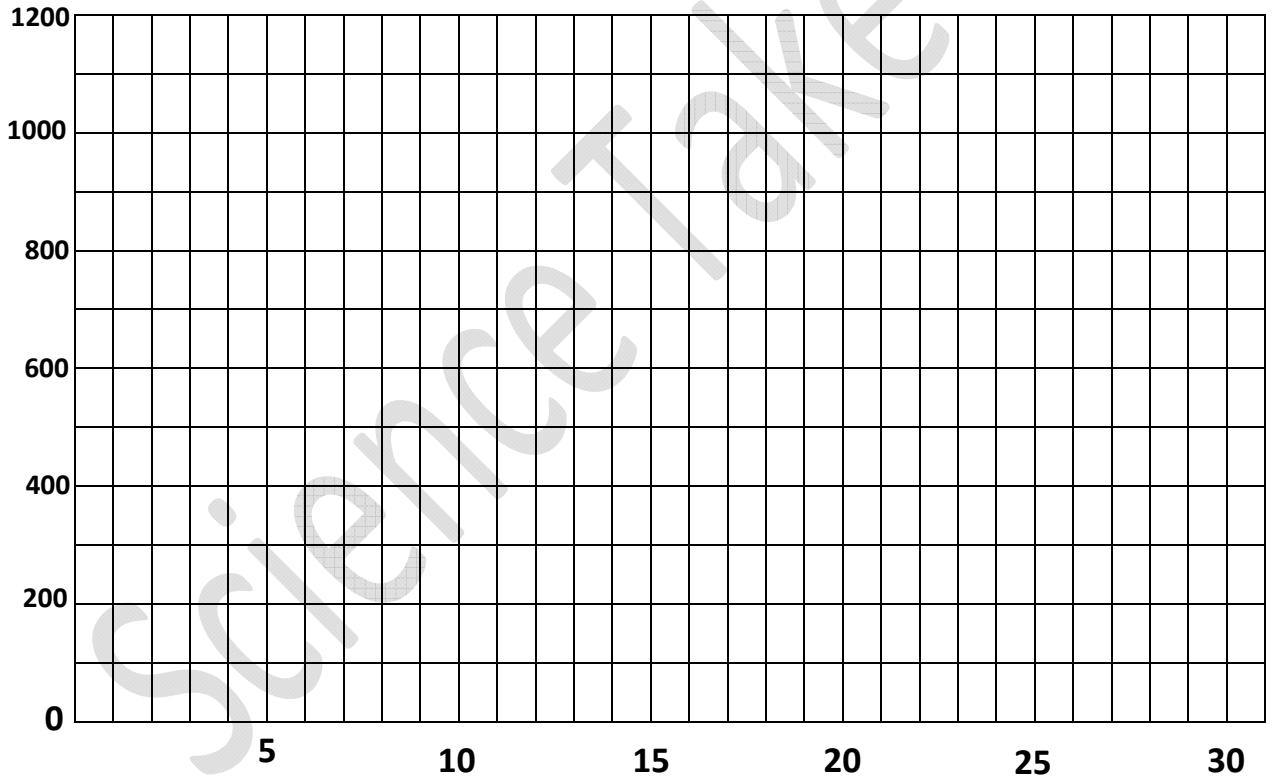
*Your name* _____

**Title:** _____

**Key:** Child 1  Child 2  Child 3 

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# MATERIAL SAFETY DATA SHEET

## 1. PRODUCT AND COMPANY IDENTIFICATION

| Product Name (as printed on the label) | Product identity |
|---|---|
| Day 0 | Buffer pH 3 |
| Day 10 | Buffer pH 6 |
| Day 20 | Buffer pH 6 |
| Day 30 | Buffer pH 10 |

Distributor: ScholAR Chemistry; 5100 W. Henrietta Rd, Rochester, NY 14586; (866) 260-0501; www.Scholarchemistry.com

Telephone number for information: (718)338-3618 Medical emergency phone number (Chemtrec): (800) 424-9300

Date of this MSDS: 12/1/12

Medical emergency phone number (Chemtrec): (800) 424-9300

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## 2. COMPOSITION/INFORMATION ON INGREDIENTS

| Product | Ingredients | CAS Numbers | % Weight/Volume (balance is water) |
|---|---|---|---|
| pH 3 buffer | Sulphamic acid<br>Potassium biphthalate | 5329-14-16<br>877-24-7 | 0.10%<br>0.35% |
| pH 6 buffer | Potassium phosphate monobasic<br>Sodium phosphate dibasic | 7778-77-0<br>7558-79-4 | 0.38%<br>0.08 |
| pH 10 buffer | Sodium carbonate<br>Sodium bicarbonate | 497-19-8<br>144-55-8 | 0.25%<br>0.15% |

For all the ingredients

OSHA PEL: TWA – none estab. STEL – none estab.
ACGIH TLV: TWA – none estab. STEL – none estab.
NIOSH REL: TWA – none estab. STEL – none estab.
NIOSH ILDH: none estab.

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## 3. HAZARDS IDENTIFICATION – for all pH buffer products

**EMERGENCY OVERVIEW**
Do not ingest. Avoid skin and eye contact. Avoid exposure to vapor or mists.

Potential Health Effects

EYES: May cause irritation. SKIN: May cause irritation. INHALATION: n/a
INGESTION: May cause gastrointestinal discomfort and mouth burns .

## 4. FIRST AID MEASURES – for all pH buffer products

EYES - Flush with water for at least 15 minutes, raising and lowering eyelids occasionally. Get medical attention if irritation persists.

SKIN - Thoroughly wash exposed area for at least 15 minutes. Remove contaminated clothing. Launder contaminated clothing before reuse. Get medical attention if irritation persists.

INGESTION - Do not induce vomiting. If swallowed, if conscious, give plenty of water immediately and call a physician or poison control center. Never give anything by mouth to an unconscious person.



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**5. FIRE FIGHTING MEASURES – for all pH buffer products**

NFPA Rating: Health: 1 Fire: 0 Reactivity: 0

Extinguisher Media: Any means suitable for extinguishing surrounding fire

Special Firefighting Procedures: Firefighters should wear full protective equipment and NIOSH approved self-contained breathing apparatus.

Unusual Fire and Explosion Hazards: No data available

**6. SPILL OR LEAK PROCEDURES – for all pH buffer products**

Ventilate area of spill. Clean-up personnel should wear proper protective equipment and clothing. Absorb material with suitable absorbent and containerize for disposal.

**7. HANDLING AND STORAGE – for all pH buffer products**

Store in a cool dry place. This Material is not considered hazardous. Handle using safe laboratory practices.

**8. EXPOSURE CONTROLS/PERSONAL PROTECTION – for all pH buffer products**

Respiratory Protection: n/a

Ventilation: Local Exhaust: Preferred
Mechanical(General): Acceptable
Special: No
Other: No

Protective Gloves: Natural rubber, Neoprene, PVC or equivalent.
Eye Protection: Splash proof chemical safety goggles should be worn.
Other Protective Clothing or Equipment: Lab coat, apron, eye wash, safety shower.

**9. PHYSICAL AND CHEMICAL PROPERTIES – for all pH buffer products**

Melting Point: ~0°C Boiling Point: ~100°C

Vapor Pressure: information not available Vapor Density: information not available

Specific Gravity ($H_2O$=1): ~1 Percent Volatile by Volume: >99

Evaporation Rate: information not available Solubility in Water: soluble

Appearance and Odor: Clear colorless liquid

**10. STABILITY AND REACTIVITY – for all pH buffer products**

Stability: Stable Materials to Avoid: strong acids and bases

Hazardous Decomposition Products: none known Hazardous Polymerization: will not occur



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**11. TOXICOLOGICAL INFORMATION**

| Ingredient | Toxicity (oral-rat) $LD_{50}$ |
|---|---|
| Sulphamic acid | 3160 mg/kg |
| Potassium biphthalate | 3200 mg/kg |
| Sodium phosphate dibasic | 17 g/kg |
| Potassium phosphate monobasic | 7100 mg/kg |
| Sodium carbonate | 4090 mg/kg |
| Sodium bicarbonate | 4220 mg.kg |

Effects of Overexposure (for all pH buffers):

Acute: Essentially non-hazardous. Possible irritation of eyes/skin/stomach
Chronic: None known.
Conditions aggravated/Target organs: none known

Target Organs: Eyes, skin, and gastrointestinal tract.

Primary Route(s) of Entry: Ingestion or skin contact.

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**12. ECOLOGICAL INFORMATION – for all pH buffer products**

No ecological data available

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**13. DISPOSAL CONSIDERATIONS – for all pH buffer products**

Waste Disposal Methods: Dispose in accordance with all applicable Federal, State and Local regulations.

Always contact a permitted waste disposer (TSD) to assure compliance.

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**14. TRANSPORTATION INFORMATION**

D.O.T. SHIPPING NAME: Not regulated

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**15. REGULATORY INFORMATION – for all pH buffer products**

EPA regulations:

RCRA Hazardous waste number (40 CFR 261.33) – not listed
RCRS Hazardous waste classification (40 CFR 261) – not classified
SARA Toxic Chemical (40 CFR 372.65) – not listed
SARA EHS (Extremely Hazardous Substance (40 CFR 355) – not listed

OSHA regulations:

Air Contaminant (29 CFR 1910.1000) – not listed

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**16. ADDITIONAL INFORMATION**

The information provided in this Material Safety Data Sheet represents data from the manufacturer and/or vendor and is accurate to the best of our knowledge. By providing this information, Science Take-Out LLC makes no guarantee or warranty, expressed or implied, concerning the safe use, storage, handling, precautions, and/or disposal of the products covered or the accuracy of the information contained in this fact sheet. It is the responsibility of the user to comply with local, state, and federal laws and regulations concerning the safe use, storage, handling, precautions, and/or disposal of products covered in this fact sheet.



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