



Disease Detectives

Teacher Information

..... just add students™

Summary

Students use symptoms and laboratory tests to diagnose which disease is causing a patient's fever and severe headache. They explore the importance of vaccinations to prevent meningitis.

Core Concepts

- Symptoms and laboratory tests can be used to diagnose diseases.
- Meningitis is a serious infection that can lead to permanent brain damage or death.
- A vaccine can prevent the most common forms of bacterial meningitis.

Time Required

Two 40-minute class periods

Kit contains

- **Fact Sheet: Meningitis**
- **CSF (cerebrospinal fluid) Testing Procedures**
- **Glucose and Protein Test Sheet**
- **Patient's White Blood Cells** diagram
- Tube of Patient CSF
- Tube of Protein Test Solution
- Glucose Test Paper
- **Antibody Coated Bead Test Sheet**
- Tube of *Nm* Antibody-Coated Beads
- Tube of *Sp* Antibody-Coated Beads
- Tube of *Hi* Antibody-Coated Beads
- 5 labeled droppers

Teacher Provides

- Access to water
- Paper towel for clean-up
- Safety goggles

Optional

If students are working in teams, you may make a copy of the **Fact Sheet: Meningitis** for each student.

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 component.

Reusing kits

Kits may be refilled and reused. Allow approximately 30 minutes for refilling 10–15 student kits. Teachers will need to instruct students on how to handle clean-up and return of the reusable kit materials. For example, teachers might provide the following information for students:

Discard	Rinse with water and dry with paper towel	Refill and Return to kit
Used glucose test strips	• Glucose and Protein Test Sheet • Antibody-Coated Bead Test Sheet	• Patient CSF • Protein Test Solution • <i>Nm</i> Antibody-Coated Beads • <i>Sp</i> Antibody-Coated Beads • <i>Hi</i> Antibody-Coated Beads • Bag of Glucose Test Strips

Refills for the *Disease Detectives* kits are available at www.sciencetakeout.com. The 10 Kit Refill Pack includes the following materials:

- 15 ml Patient CSF
- 10 ml Protein Test Solution
- 10 ml *Nm* Antibody-Coated Beads
- 10 ml *Sp* Antibody-Coated Beads
- 10 ml *Hi* Antibody-Coated Beads
- 10 strips of Glucose Paper

Optional Extension Activity

Teens and young adults are particularly at risk for contagious bacterial meningitis. The optional extension activity on the following four pages may be used if you would like to engage your students in research on the importance of vaccination to prevent bacterial meningitis.

Suggested Internet resources for this activity include:

- CDC Meningitis <http://www.cdc.gov/meningitis/index.html>
- KidsHealth: Meningitis <http://kidshealth.org/parent/infections/lung/meningitis.html>
- MedlinePlus: Meningitis <http://www.nlm.nih.gov/medlineplus/meningitis.html>

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Important Notice for All Students and Parents!

Students and parents should be aware that a student at City High School has been diagnosed with **bacterial meningitis**. Bacterial meningitis is especially dangerous because it is contagious and can cause serious illness or death. Signs and symptoms of meningitis include: high fever, headache, stiff neck, and vomiting.

For further information on bacterial meningitis, please see the US Centers for Disease Control and Prevention (CDC) website:
www.cdc.gov/meningitis/about/index.html

The school board has established a new requirement that all students **age 11 or older** provide evidence that they have received the meningococcal vaccine (MCV4) that prevents bacterial meningitis. Students who have not already received the meningococcal vaccine (MCV4) may receive this vaccination through their physician or at free clinics set up in all district schools.

For further information on the **meningococcal vaccine (MCV4)**, visit the Centers for Disease Control website at
www.cdc.gov/meningitis/vaccine-info.html

1. Have you been vaccinated for bacterial meningitis? (Ask your parents if you are not sure.)
2. Why do you think some parents support the requirement that all students be vaccinated for bacterial meningitis?
3. Why do you think some parents oppose the requirement that all students be vaccinated for bacterial meningitis?

4. Approximately 80% of teens have received the bacterial meningitis vaccine. List two possible reasons why 20% of teens have not been vaccinated?

5. Visit the CDC website and two additional websites to learn more about the meningococcal vaccine (MCV4). Use the information from these websites to complete the **Pre-writing Grid**. A pre-writing grid can help you organize information to be used in writing.
 - Write the title and Internet address for your three sources at the top of each column.
 - Write information related to each of the questions in the appropriate columns.

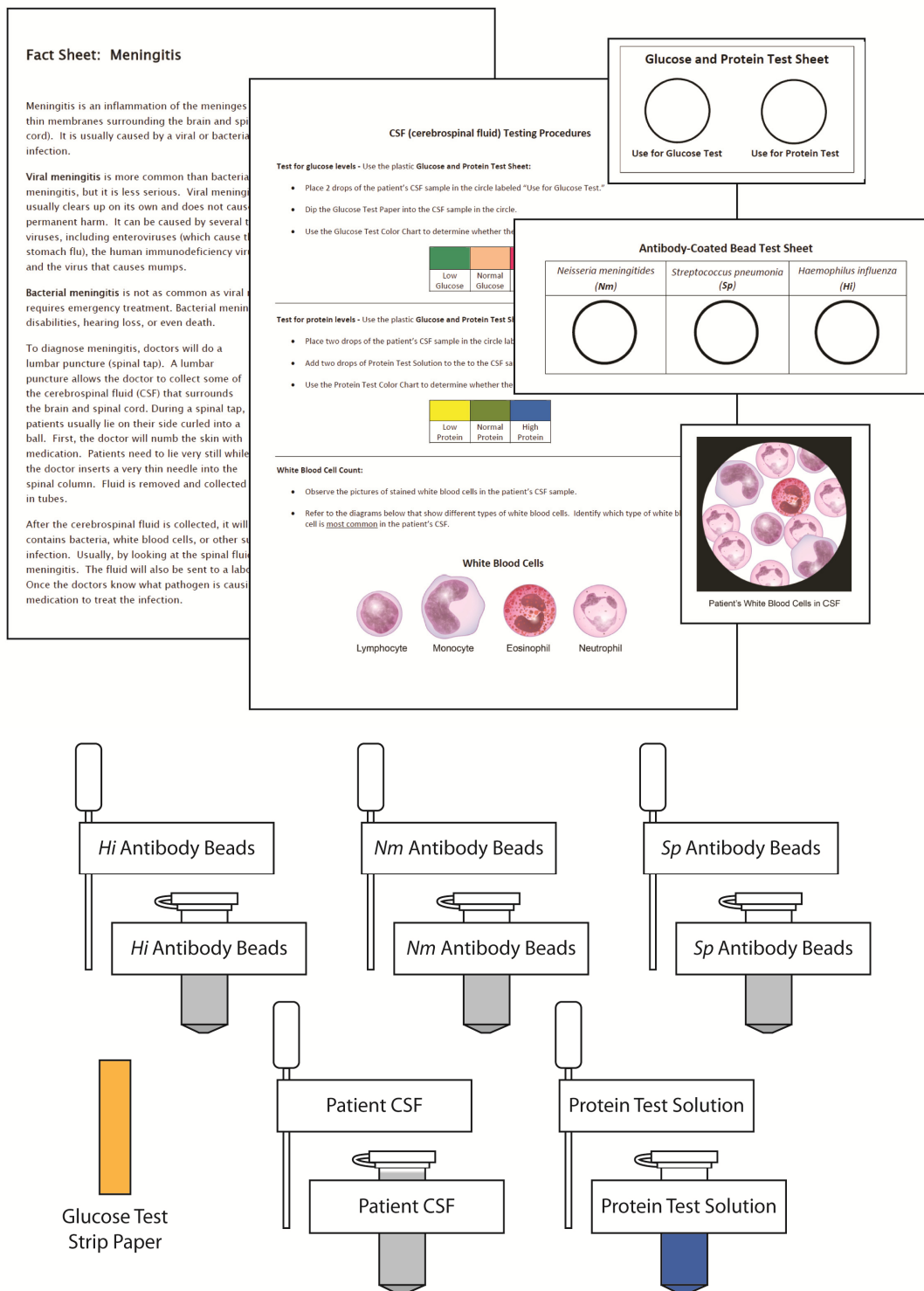
6. Write a letter to encourage all parents to have their children vaccinated with the meningitis vaccine. Your letter should include the answers to all of the questions in the Pre-writing Grid.

Pre-writing Grid

	Source 1 Website	Source 2 Website	Source 3 Website
What substance in a meningitis vaccine makes it effective?			
How does the meningitis vaccine work to prevent meningitis?			
Does the meningitis vaccine prevent all types of meningitis?			
What are the advantages of the use of vaccinations to prevent meningitis?			

What are the disadvantages of using antibiotics to prevent meningitis?			
Why are other vaccines, such as those for influenza and tetanus, not effective in preventing meningitis?			
Is the meningitis vaccine safe and effective?			
What other information might be helpful to convince parents that it is important to be vaccinated to prevent meningitis?			

Kit Contents Quick Guide



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, 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.

Disease Detectives

Teacher Answer Key

Part I: What is wrong with Mike?

Yesterday, Mike Wright developed a severe headache, a high fever, and a stiff neck. Then, he became nauseated and began vomiting. He just wanted medicine to make him feel better and a dark quiet room so that he could sleep. Today, Mike's parents noticed that he was so sleepy that it was difficult to get him to wake up and he seemed confused. They took Mike to the hospital emergency room because they are worried that he is very sick.



1. Read the description of Mike's illness. Complete the "Mike's Symptoms" column in the chart below by putting an "X" in the appropriate boxes to indicate Mike's symptoms.

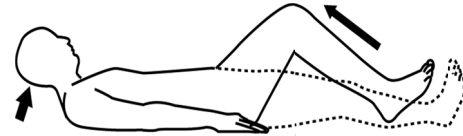
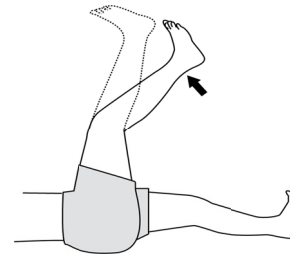
Symptoms	Mike's Symptoms	Viral Meningitis	Bacterial Meningitis	Influenza	West Nile Encephalitis
Fever					
Headache					
Cough					
Stiff neck					
Nausea and vomiting					
Light sensitivity					
Muscle aches					
Confusion					

2. Use the information on the **Possible Diseases** sheet on the last page of this lab to complete the other four columns in the chart. *Note: You may tear this page off to make it easier to complete the chart.*
3. Why is it important that doctors determine which disease is causing Mike's symptoms?
4. Based on the information in the chart, what diseases are most likely to be causing Mike's symptoms?

Part 2: Is it Viral or Bacterial Meningitis?

The emergency room doctor found two worrisome symptoms that indicate Mike Wright may have meningitis.

- An inability to straighten his legs when his hips were flexed to 90 degrees.
- Severe neck stiffness that caused his hips and knees to flex when his neck was flexed.



Use the information in the **Fact Sheet: Meningitis** to answer questions 1 through 4.

1. What is meningitis?
2. Why is it important to determine if Mike has bacterial meningitis or viral meningitis?
3. Which type of meningitis (bacterial or viral) requires immediate treatment with antibiotics?
4. The doctor orders a lumbar puncture to collect the patient's cerebrospinal fluid (CSF).
 - What is a lumbar puncture?
 - What is cerebrospinal fluid (CSF)?

5. You will test the patient's CSF to determine if Mike has bacterial or viral meningitis. Conduct the tests described on the **CSF Testing Procedures** sheet in your lab kit.
6. Record the results of the CSF tests in the data table below

CSF Test Results for Mike Wright

	Glucose	Protein	Most Common White Blood Cells
Mike Wright (Patient)			
Bacterial meningitis	low	high	neutrophils
Viral meningitis	normal	normal or high	lymphocytes

7. Based on the results of Mike Wright's CSF tests, what type of pathogen is causing his meningitis—a viral pathogen or a bacterial pathogen?

Part 3: Which Type of Bacteria?

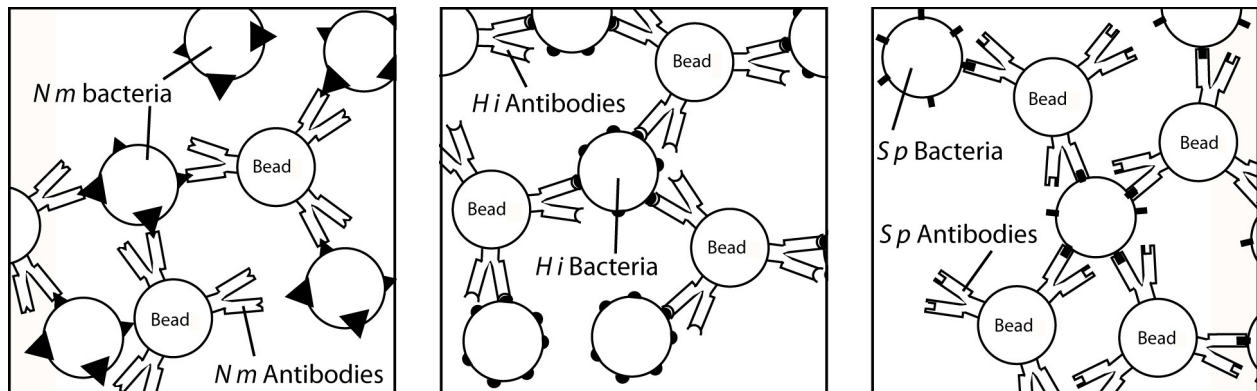
There are three types of bacteria that commonly cause bacterial meningitis:

- *Streptococcus pneumonia* (*Sp*)
- *Neisseria meningitides* (*Nm*)
- *Haemophilus influenza* (*Hi*)

1. Use the information in the **Fact Sheet: Meningitis**. State two reasons why it is important to know which specific type of bacteria may be causing Mike's meningitis.

Base your answers to questions 2 through 5 on the information in the box below.

An **antibody-coated bead test** can be used to identify the type of bacteria that are causing the patient's meningitis. This test uses microscopic beads coated with specific kinds of **antibodies** that can combine with specific **antigens** (proteins) on the surface of bacteria. When antigens on the bacteria attach to the antibodies on the beads, the beads will clump together and appear as a white cloudy substance.



2. Explain how the three specific kinds of antibodies (*Nm* antibodies, *Hi* antibodies, and *Sp* antibodies) attached to the beads are different.

3. Explain how the three specific kinds of bacteria (*Nm* bacteria, *Hi* bacteria, and *Sp* bacteria) are different.
4. Explain why *Nm* bacteria clump together when mixed with beads that are coated with *Nm* antibodies. Use the words antigen and antibody in your answer.
5. Explain why *Hi* bacteria do **not** clump together when mixed with beads that are coated with *Nm* antibodies. Use the words antigen and antibody in your answer.
6. Follow the instructions below to test the Patient CSF to determine which type of bacteria is causing Mike's meningitis. Use the **Antibody-Coated Bead Test Strip** and three tubes of beads (*Nm*, *Sp*, and *Hi*) provided in your kit.
 - a. Place two drops of antibody-coated beads (*Nm* beads, *Sp* beads, or *Hi* beads) in the appropriate circles on the Antibody-Coated Bead Test Sheet.
 - b. Place two drops of the Patient CSF into each of the circles on the Antibody-Coated Bead Test Sheet.
 - c. A cloudy appearance indicates that Patient CSF contains that specific type of bacteria. It is easier to see the cloudy appearance if the test sheet is placed on a dark surface.
7. Which antibody-coated beads turned cloudy when mixed with the Patient CSF?
8. Explain what caused these antibody-coated beads, and not the other antibody-coated beads, to turn cloudy. Use the words antigens and antibodies in your answer.

9. What type of bacteria is causing the patient's meningitis? Support your answer with evidence from the Antibody-Coated Bead Test.

Use the information in the Fact Sheet: Meningitis to answer questions 10 through 15.

10. State two reasons why meningitis caused by this type of bacteria is considered serious.

11. Explain how meningitis bacteria damage the brain. Be specific!

12. What health problems might result from this brain damage? Be specific!

13. What treatments can be used for a patient with this type of meningitis?

14. How could this type of meningitis be prevented?

15. What action should be taken by unvaccinated people who may have been exposed to the bacteria that cause this type of meningitis?

Possible Diseases

Viral Meningitis Viral meningitis is an infection of the meninges (the covering of the brain and spinal cord) that is caused by a virus. People with viral meningitis usually recover completely without specific treatment. There are several viruses that can cause viral meningitis. Most viral meningitis cases are caused by enteroviruses that infect the digestive tract. Other viruses that can cause meningitis include the viruses that cause mumps, chicken pox, influenza, and measles. Viral meningitis infection is characterized by a sudden onset of fever, headache, and stiff neck. It is often accompanied by other symptoms, such as nausea, vomiting, sensitivity to light, and confusion.	Bacterial Meningitis Bacterial meningitis is a serious and sometimes fatal infection of the meninges (the covering of the brain and spinal cord) that is caused by bacteria. While most people with bacterial meningitis recover, the disease can cause serious complications, such as brain damage, hearing loss, learning disabilities, or even death. There are several types of bacteria that can cause bacterial meningitis. Common causes of bacterial meningitis include <i>Streptococcus pneumoniae</i>, <i>Neisseria meningitidis</i>, and <i>Haemophilus influenza</i>. Early symptoms of meningitis infection include a sudden onset of fever, headache, and stiff neck. Other symptoms may include nausea, vomiting, increased sensitivity to light, and confusion. Later symptoms of bacterial meningitis include seizures and coma.
Influenza Influenza (the flu) is a contagious respiratory illness caused by influenza viruses that infect the nose, throat, and lungs. It can cause mild to severe illness, and at times can lead to death. People who have the flu often have a fever, headache, cough, fatigue, and muscle or body aches. Some people also experience vomiting and diarrhea. Flu is unpredictable, and how severe it is can vary widely depending on the type of virus causing it. Older people, young children, pregnant women and people with certain health conditions (such as asthma, diabetes, or heart disease), and persons who live in facilities like nursing homes may be more at risk for severe flu symptoms.	West Nile Encephalitis West Nile encephalitis is a potentially serious disease caused by the West Nile virus. This virus is often transmitted by the bite of an infected mosquito. Mosquitoes become infected when they feed on infected birds. Most people who become infected with the virus will not show any symptoms. However, some people have symptoms such as fever, headache, body aches, nausea, and vomiting. Rarely, infected people experience confusion, coma, tremors, convulsions, muscle weakness, vision loss, numbness and paralysis.

Science Take-Out

MATERIAL SAFETY DATA SHEET

1. PRODUCT AND COMPANY IDENTIFICATION

Product Name (as printed on the label):

"Patient CSF", "Nm Antibody Beads", "Sp Antibody Beads", and "Hi Antibody Beads"

Product identity: Food coloring – < 0.01% Inorganic salts – 0-15%
Water – 84-100%

Manufacturer: Science Take-Out, LLC
P.O. Box 205
Pittsford, NY 14534

Telephone number for information: (585)764-5400

Preparation date of this MSDS: 8/19/13

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

2. COMPOSITION/INFORMATION ON INGREDIENTS

This product contains no hazardous materials as defined by the OSHA Hazards Communications Standard

Chemical Ingredients: Red food coloring (1%) Chemical Name: N/A

CAS Number: N/A Formula: N/A Synonyms: N/A

Principle Hazardous Components: No Data

TLV and PEL units: No Data OSHA-PEL 10ppm (TWA): No Data

3. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW

Avoid skin and eye contact.

Potential Health Effects EYES: May cause irritation. SKIN: May cause irritation.

4. FIRST AID MEASURES

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.

5. FIRE FIGHTING MEASURES

No data available

6. SPILL OR LEAK PROCEDURES

Wear proper eye and skin protection. Mop/wipe spill area. Rinse with water.

7. HANDLING AND STORAGE

Avoid eye and skin contact

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Respiratory Protection: N/A Ventilation: N/A

Protective Gloves: Natural rubber, Neoprene, PVC or equivalent.

Eye Protection: Splash proof chemical safety goggles should be worn.

Other Protective Clothing or Equipment: None

9. PHYSICAL AND CHEMICAL PROPERTIES

Molecular Weight: No data Melting Point: N/A

Boiling Point: No data Vapor Pressure: No data

Vapor Density (Air=1): No data Specific Gravity (H₂O=1): No data

Percent Volatile by Volume: No data Evaporation Rate (BuAc=1): No data

Solubility in Water: Soluble

Appearance and Odor: Simulated "blood" - Red liquid; Anti-A – Yellow liquid; Anti B – Blue liquid

10. STABILITY AND REACTIVITY

Stability: Stable

Conditions to Avoid: No data

Incompatibility (Materials to Avoid): None

Hazardous Decomposition Products: No Data

Hazardous Polymerization: Will not occur

11. TOXICOLOGICAL INFORMATION

Toxicity Data: No data

Effects of Overexposure: See section 3

Target Organs: Eyes and skin

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

12. ECOLOGICAL INFORMATION No data

13. DISPOSAL CONSIDERATIONS Can be disposed of in trash or down the sink.

14. TRANSPORTATION INFORMATION D.O.T. SHIPPING NAME: N/A

15. REGULATORY INFORMATION N/A

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.

MATERIAL SAFETY DATA SHEET

1. PRODUCT AND COMPANY IDENTIFICATION

Product Name (as printed on the label): "Protein Test Solution"

Product identity: 0.01% bromothymol blue solution

Distributor: Science Take-Out, LLC. PO Box 205, Pittsford, NY 14534

Telephone number for information: (585)764-5400 Medical emergency phone number (Chemtrec): (800) 424-9300

Date of this MSDS: 8/19/13

2. COMPOSITION/INFORMATION ON INGREDIENTS

Ingredients	CAS Numbers	% Weight/Volume	TLV Units
Bromothymol blue sodium salt	34722-90-2	0.01%	None established
Water	7732-18-5	99.99%	None established

3. HAZARDS IDENTIFICATION

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 slight irritation. INHALATION: n/a
INGESTION: May cause gastrointestinal discomfort

4. FIRST AID MEASURES

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.

5. FIRE FIGHTING MEASURES

NFPA Rating: Health: 1 (slight) Fire: 0 Reactivity: 0

Extinguisher Media: Any means suitable for extinguishing surrounding fire

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

Unusual Fire and Explosion Hazards: None

6. SPILL OR LEAK PROCEDURES

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

7. HANDLING AND STORAGE

Store in a cool dry place. Handle using safe laboratory practices.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Respiratory Protection: None required

Ventilation: Local Exhaust: Preferred

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

Melting Point: <2°C

Vapor Pressure: Ca 50 @ 20°C

Specific Gravity (H₂O=1): ~1

Evaporation Rate: ~ same as water

Appearance and Odor: Green liquid

Boiling Point: >98°C

Vapor Density: ~ same as water

Percent Volatile by Volume: information not available

Solubility in Water: soluble

10. STABILITY AND REACTIVITY

Stability: Stable

Materials to Avoid: none known

Hazardous Decomposition Products: none

Reactive under what conditions: none known

11. TOXICOLOGICAL INFORMATION

Toxicity (rat) LD ₅₀
Acute oral toxicity = information not available
Acute toxicity from vapor = information not available

Effects of Overexposure:

Acute: Irritation of eyes/skin

Chronic: Irritation of eyes/skin

Target Organs: Eyes, skin.

Primary Route(s) of Entry: Ingestion

12. ECOLOGICAL INFORMATION

No data available

13. DISPOSAL CONSIDERATIONS

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

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

14. TRANSPORTATION INFORMATION

No data available

15. REGULATORY INFORMATION

No data available

16. ADDITIONAL INFORMATION

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