



Mosquito Invasion

Teacher Information

.....just add students™

Summary

A man and his dog are both infected with heartworm, a disease that is caused by a worm carried by mosquitoes. Explore how an invasive species of mosquito combined with climate change can lead to an increase in heartworm and other diseases carried by mosquitoes.

Core Concepts

- Mosquitoes can transmit diseases to humans and other animals.
- Asian tiger mosquitoes are an invasive species whose range in the United States is expanding.
- Climate change is predicted to expand the range of the Asian tiger mosquito and lead to outbreaks of mosquito-borne diseases.
- A One Health approach identifies and seeks solutions to problems that affect the health of humans, animals, and the environment.

Time Required

2–3 forty-minute class periods

Kit Contains

- Sasha's Blood Plasma (simulated)
- *Dirofilaria immitis* Test Strip (simulated)
- **Distribution of *Aedes albopictus* Mosquitoes**
- **Distribution of Veterinary Cases of Heartworm**
- **Asian Tiger Mosquitoes: Vectors for Diseases**

Teacher Provides

- Access to internet
- Paper towels for clean-up

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.

Teacher Resources

- **Centers for Disease Control and Prevention (CDC): One Health**
<https://www.cdc.gov/onehealth/index.html>
- **USDA: Asian Tiger Mosquito**
<https://www.invasivespeciesinfo.gov/profile/asian-tiger-mosquito>
- **Man's best friend: How humans can develop *Dirofilaria immitis* infections**
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4816904/>
- **American Heartworm Society: Think 12 Resource Center**
<https://www.heartwormsociety.org/veterinary-resources/client-education/think-12>
- **Invasive Mosquitoes Brochure**
<https://www.cdph.ca.gov/Programs/CID/DCDC/CDPH%20Document%20Library/InvasiveMosquitoesBrochure.pdf>

Teacher Suggestions

- Internationally, there is a growing focus on utilizing One Health approaches to solve problems that involve the health of humans, animals, and the environment. One Health problems are complex and solutions to these problems require the collaboration of people from a variety of disciplines. It is important that students are exposed to this type of interdisciplinary and collaborative thinking.
- Asian tiger mosquitoes are a One Health problem that involves the health of humans, animals, and the environment. An optional Part 5 on the following two pages helps students understand what One Health means and see the importance of taking a collaborative One Health approach to solving the problem of invasive Asian tiger mosquitoes. Students will need access to the internet to view this YouTube video:
<https://www.youtube.com/watch?app=desktop&v=TG0pduAYESA>
- You may want to ask students to brainstorm examples of other One Health problems and explain how the One Health approach may involve a collaboration of people who have careers in human health, environmental health, and animal health.

Part 5: One Health and invasive Asian tiger mosquitoes

One Health

The State Health Department is suggesting that local governments should take a collaborative One Health approach to solving complex local problems, such as the invasion of Asian tiger mosquitoes. A One Health approach uses the idea that complex problems often involve the health of people, animals, and the environment. Therefore, solutions to One Health problems must be designed to protect the health of people, animals, and the environment.



1. Use the information in the text box above to explain what must be involved in a complex problem for it to be considered a One Health problem.

2. Watch this video from the CDC (Centers for Disease Control). The video provides a brief introduction to One Health and why it is important for public health professionals, veterinarians, ecologists, and environmental health professionals to work together.

Scan this QR code with your smartphone or tablet camera app to link to the video.



3. State one interesting or important thing that you learned about One Health from watching the video.

To support adoption of a One Health approach, the health department officials want to create a series of slides to provide examples of One Health problems in the community. Your team has been hired to create three slides to answer the question, **“Why are Asian tiger mosquitoes a One Health problem?”**

Remember how the CDC video used images with captions (short descriptions) to help people understand what One Health problems and solutions involve. Using pictures and captions in your slides will help people understand and remember what the One Health approach involves.

2. Use the information in the text box above, what you learned from the video, and what you learned about Asian tiger mosquitoes to develop three slides that show why invasive Asian tiger mosquitoes are a One Health problem. You should create three slides:
 - Slide 1: A picture (or pictures) and a caption to explain how animals are involved in the problem.
 - Slide 2: A picture (or pictures) and a caption to explain how humans are involved in the problem.
 - Slide 3: A picture (or pictures) and a caption to explain how the environment is involved in the problem.

Reusing the Kit

Teachers will need to instruct students on how to handle cleanup and return of the reusable kit materials. For example, teachers might provide the following information for students:

Discard	Return to kit bag
Used Rapid Test Strips	- Small tube of Sasha's Blood Plasma - Bag for Rapid Test Strip - Distribution of <i>Aedes albopictus</i> Mosquitoes - Distribution of Veterinary Cases of Heartworm - Asian Tiger Mosquitoes: Vectors for Diseases

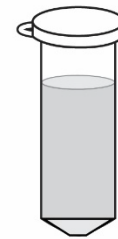
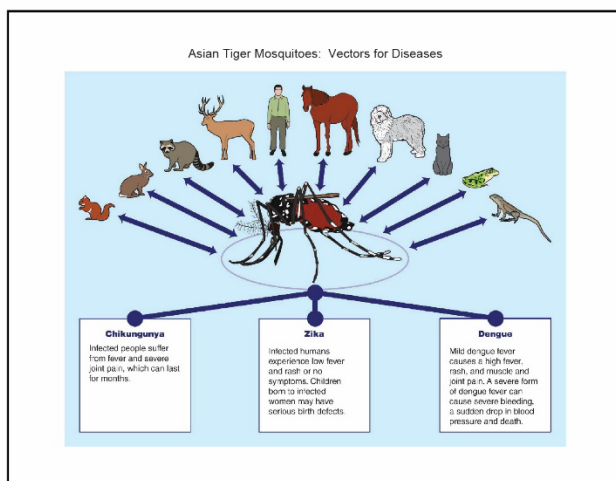
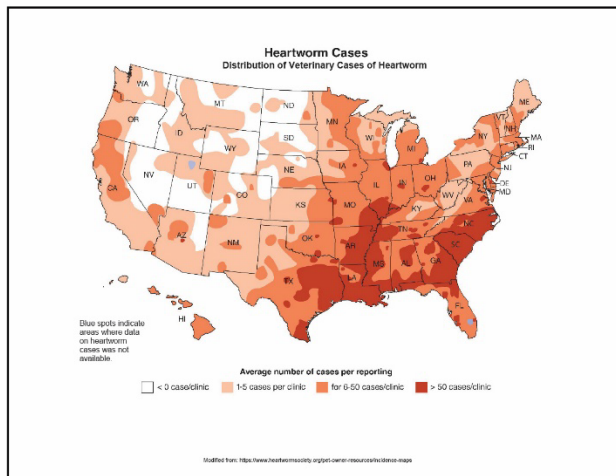
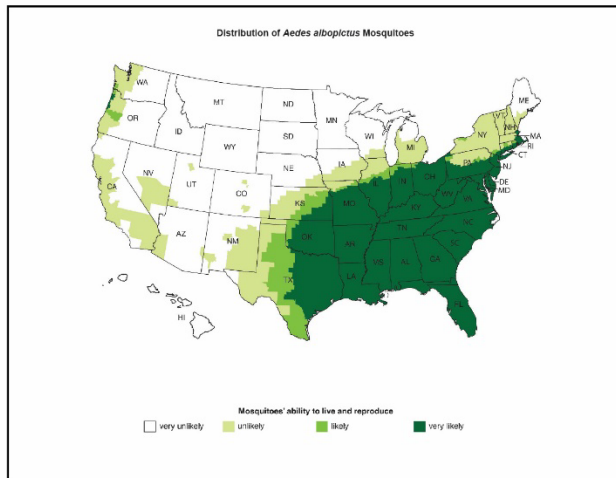
Refills for **Mosquito Invasion** kits are available at www.sciencetakeout.com. The **10 Kit Refill Pack** includes the following materials:

- 10 Rapid Test Strips (simulated)
- 20 mL of Sasha's Blood Plasma (simulated)
- transfer pipet

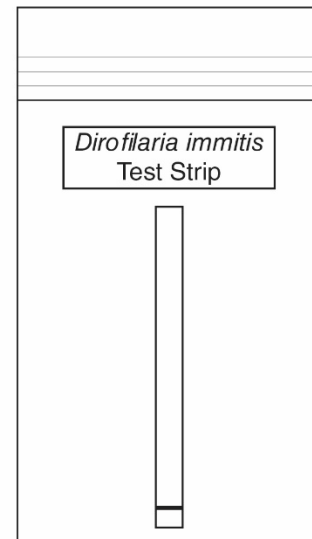
NGSS Correlation

Working Towards Performance Expectations • MS-LS2-2. Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems. • HS-LS2-6. Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.		
Science and Engineering Practices Analyzing and Interpreting Data Use graphical displays (e.g., maps, charts, graphs, and/or tables) of large data sets to identify temporal and spatial relationships.	Disciplinary Core Ideas LS2.A: Interdependent Relationships in Ecosystems Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared. LS2.C: Ecosystem Dynamics, Functioning, and Resilience A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability.	Cross Cutting Concepts Stability and Change Much of science deals with constructing explanations of how things change and how they remain stable.

Kit Contents Quick Guide



Sasha's Blood Plasma



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.

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. Safety Data Sheets (SDS) provide specific safety information regarding the chemical contents of the kits. SDS information for each kit is provided in the accompanying teacher instructions. We encourage students to adopt safe lab practices when performing laboratory activities involving chemicals.

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.

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.

General Safety Precautions

1. Never taste, smell, or ingest any chemicals provided in the kit – they may be hazardous.
2. 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.
3. Report any chemical spills or contact with chemicals to your teacher.
4. Work in a clean, uncluttered area. Cover the work area to protect the work surface.
5. Read and follow all instructions carefully.
6. Pay particular attention to following the specific safety precautions provided by your teacher or included in the kit activity instructions.
7. Do not use the contents of this kit for any other purpose beyond those described in the kit instructions.
8. Do not leave experiment parts or kits where they could be used inappropriately by others.
9. Do not eat, drink, or apply make-up or contact lenses while performing experiments.
10. Wash your hands before and after performing experiments.

Mosquito Invasion

Part 1: A surprising diagnosis

Mario had a mild but annoying cough. His doctor recommended that he have a lung CT scan to screen for lung cancer. Mario's CT scan (Figure 1) revealed a pulmonary (lung) nodule.

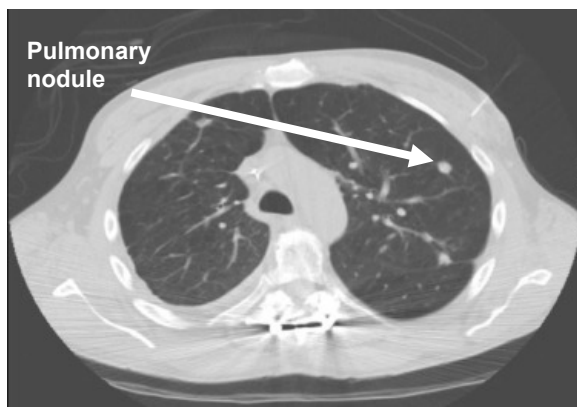


Figure 1: CT scan of Mario's lungs

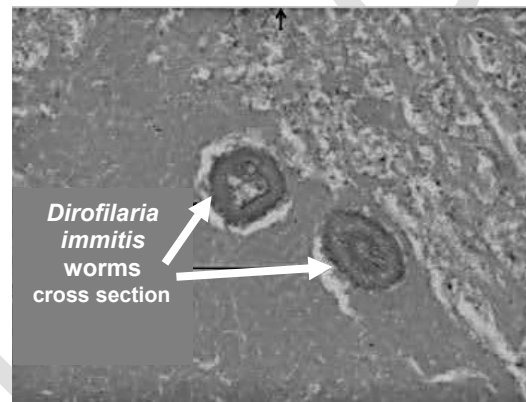
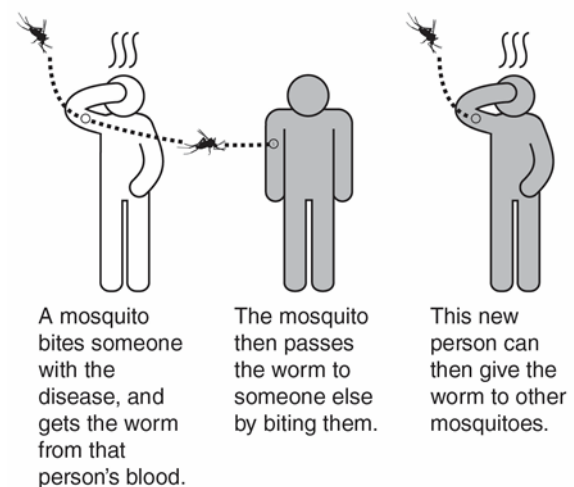


Figure 2: Microscopic examination of Mario's pulmonary nodule

Because pulmonary (lung) nodules may be cancerous, Mario had surgery to remove the pulmonary nodule. Microscopic examination of the pulmonary nodule tissue (Figure 2) did not reveal cancer. Instead, the pulmonary nodule tissue from Mario's lung contained parasitic worms called *Dirofilaria immitis*. The common name for *Dirofilaria immitis* is "heartworm."

Mario's doctors explained that mammals, such as humans and dogs, become infected with heartworm when they are bitten by mosquitoes that carry *Dirofilaria immitis*. Mosquitoes act as vectors (carriers). When mosquitoes bite a mammal infected with *Dirofilaria immitis* worms, they pick up the small worms that are in the mammal's blood. They can then transfer the worms when they bite another mammal.



Diagnosed cases of *Dirofilaria immitis* in humans are rare. People infected with *Dirofilaria immitis* usually experience no symptoms. Inside humans, heartworms grow and then die in blood vessels of the lungs. Treatment is not needed because the worms do not reproduce in humans.

1. How did Mario become infected with *Dirofilaria immitis*?

2. Why is Mario's diagnosis "surprising?"

3. Explain why it is likely that there are many humans with undiagnosed cases of *Dirofilaria immitis*.

Part 2: Pets and heartworm

Mario was worried about his dog, Sasha. Sasha has been losing weight. She is not as active as she used to be. Mario took Sasha to a veterinary clinic for a heartworm test.

One poster (shown on the right) in the vet clinic waiting room caught Mario's attention. He never realized that mosquitoes could bite pets and transmit diseases to them.



1. There was a video about dog heartworm playing on the monitor in the waiting room. Watch the video, then in the space below write one question you have about heartworm and one thing that you found interesting about heartworm.

Scan this QR code with your smartphone or tablet camera app to link to the video.



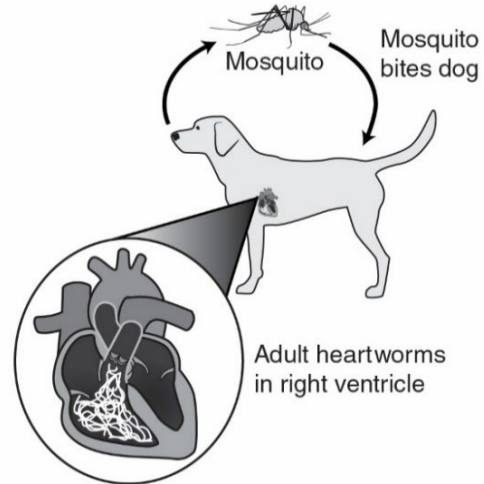
- One question you have about heartworm:

- One thing you found interesting about heartworm:

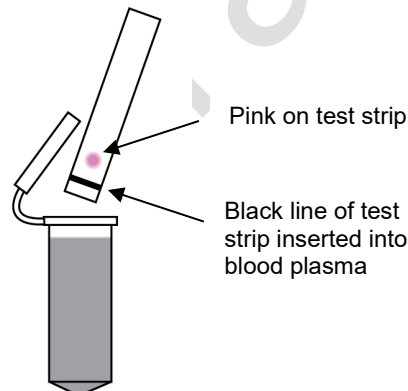
The veterinarian explained that heartworm is caused by a parasitic worm called *Dirofilaria immitis*. Mosquitoes act as vectors (carriers) to spread heartworm from one dog to another. In a dog, the heartworms cause serious health problems because they live, grow, and reproduce in the dog's heart.

All dogs should have yearly heartworm tests. Luckily, there is a simple and inexpensive test that can be done at the vet clinic to determine if the dog is infected with *Dirofilaria immitis* worms.

A veterinary assistant prepared a sample of Sasha's blood plasma (liquid part of the blood). Follow the instructions below to test Sasha's blood plasma sample for *Dirofilaria immitis*.



2. Dip the end of the ***Dirofilaria immitis* Test Strip** with the black line into the tube of Sasha's Blood Plasma for approximately 2 seconds. Be certain that at least half of the test strip is dipped into the plasma.



3. Remove the test strip from the plasma and observe the test strip.
 - If there is no pink on the test strip, the result is negative—Sasha does not have *Dirofilaria immitis* that causes heartworm disease.
 - If there is a pink area on the test strip, the result is positive—Sasha has *Dirofilaria immitis* that causes heartworm disease.
4. Does Sasha have heartworm disease? Support your answer with data from the testing.

5. Mario had a few questions that are listed below. Use the resources provided by the American Heartworm Society to answer Mario's questions.

Scan this QR code with your smartphone or tablet camera app to link to the American Heartworm Society website



- Is heartworm contagious? Could dogs, cats, or people who are in contact with Sasha get heartworm disease from her?

- The treatment for heartworms is expensive and complex. What will the *Dirofilaria immitis* worms do to Sasha's body if I do not have her treated? Be specific.

- I have a cat. Should my cat be tested for heartworm? Explain why or why not.

- What should I do to keep my pets from getting heartworm in the future? Be specific.

6. Explain why veterinarians should include information on mosquito control in their advice for pet owners.

Part 3: Mosquitoes and heartworm

Mario lives in Vermont. In the past, mosquitoes were only a problem for him in the early mornings or evenings. For the last few years, Mario has noticed a new kind of mosquito that bites aggressively during the day.

Local TV news programs have warnings about the new mosquito in the area. These mosquitoes are called the Asian tiger mosquito. The Asian tiger mosquito (scientific name *Aedes albopictus*) is an invasive species of mosquito originally found in the tropical regions of the world. Asian tiger mosquitos were first detected in Texas in 1985. They were brought to the United States in a shipment of used tires from Japan. Since then, they have spread to many parts of the United States.

Adult *Aedes albopictus* mosquitoes cannot survive cold winter temperatures. However, there is growing evidence that their eggs can survive freezing temperatures and drying, and the eggs can hatch when temperatures rise in the spring.

1. Asian tiger mosquitoes have characteristics and behaviors that make them excellent vectors (carriers) for heartworm (*Dirofilaria immitis*). View the **Asian Tiger Mosquitoes** video.

Scan this QR code with your smartphone or tablet camera app to link to the video.



List four reasons why the *Aedes albopictus* species poses a more serious disease threat than native mosquito species.

- _____
- _____
- _____
- _____

Base your answers to questions 2 through 4 on the green plastic map (**Distribution of *Aedes albopictus* Mosquitoes**) and the orange plastic map (**Distribution of Veterinary Cases of Heartworm**).

Note: Place one map on top of the other map in order to answer the questions.

2. Is *Aedes albopictus* the only type of mosquito that can transmit the heartworm? Support your answer with evidence from the maps.

3. Explain why it may be possible for *Aedes albopictus* to move into areas of the United States that are marked “unlikely” on the green map.

4. Do the two maps support the claim that the spread of *Aedes albopictus* will result in an increase in the incidence of heartworm cases in the United States? Why or why not?

Part 4: Changing climate and mosquitoes

Mario, his parents, and his neighbors have noticed that the climate in Vermont is gradually changing. Due to climate change, the summers in Vermont have been getting longer, warmer, and wetter.

Climate change, which increases the temperature and rainfall, is affecting many areas in the United States. Climate change doesn't just shift weather patterns. It can change the distribution of plants, people, animals, insects — and disease. Climate change is also making it possible for Asian tiger mosquitoes to move into new areas. It has also led to longer “mosquito seasons.” As mosquito seasons get longer, Asian tiger mosquito populations have more time to reproduce and spread disease.

1. Describe two ways that climate change will increase the number of people who are bitten by Asian tiger mosquitoes.

- _____
- _____

Base your answers to questions 2 and 3 on the illustration in your kit, **Asian Tiger Mosquitoes: Vectors for Diseases**.

2. Explain why the feeding habits of *Aedes albopictus* mosquitoes make it likely that they could spread serious diseases from a variety of animals to humans.

3. Predict what the future might be like if climate change resulted in large populations of Asian tiger mosquito populations in your community.

4. As climate change occurs, it will be important for individuals in many parts of the country to take actions to control mosquitoes in and around their homes. Use information from the **Controlling Mosquitoes at Home** web page to identify at least two things that individuals could do to control mosquitoes in or near their homes.

Scan this QR code with your smartphone or tablet camera app to link to the **Controlling Mosquitoes at Home** web page.



- _____
- _____

5. As climate change occurs, it will be important that communities use integrated mosquito management (IMM) methods to develop plans for controlling Asian tiger mosquitoes and preventing outbreaks of diseases that they carry. Use the information from the **What Mosquito Control Programs Do** web page to identify at least three things that communities could do to reduce the risks of mosquito-borne diseases.

Scan this QR code with your smartphone or tablet camera app to link to the **What Mosquito Control Programs Do** web page.



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- _____
- _____

Section 1 Chemical Product and Company Information

Science Take-Out
150 Office Park Way
Pittsford, NY 14534
(585)764-5400

CHEMTREC 24 Hour Emergency
Phone Number (800) 424-9300
For laboratory use only. Not for drug, food or household use

Product	Buffer Solution pH10
Synonyms	"Sasha's Blood Plasma"

Section 2 Hazards Identification

This substance or mixture has not been classified at this time according to the Globally Harmonized System (GHS) of Classification and Labeling of Chemicals.

Signal word: WARNING
Pictograms: None required
Target organs: None known

GHS Classification:
Skin irritation (Category 3)
Eye irritation (Category 2B)

GHS Label information: Hazard statement(s):
H316: Causes mild skin irritation.
H320: Causes eye irritation.

Precautionary statement(s):

P264: Wash hands thoroughly after handling.

P305+P351+P338: IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.

P332+P313: If skin irritation occurs: Get medical attention.

P337+P313: If eye irritation persists: Get medical attention.

Ca Prop 65 - This product does not contain any chemicals known to the State of California to cause cancer, birth defects, or any other reproductive harm.

Section 3 Composition / Information on Ingredients

Chemical Name	CAS #	%	EINECS
Water	7732-18-5	99.08%	231-791-2
Potassium chloride	7447-40-7	0.40%	231-211-8
Boric acid	10043-35-3	0.33%	233-139-2
Sodium hydroxide	1310-73-2	0.19%	215-185-5

Section 4 First Aid Measures

INGESTION: Call physician or Poison Control Center immediately. Induce vomiting only if advised by appropriate medical personnel. Never give anything by mouth to an unconscious person.

INHALATION: Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.

EYE CONTACT: Check for and remove contact lenses. Flush thoroughly with water for at least 15 minutes, lifting upper and lower eyelids occasionally. Get immediate medical attention.

SKIN ABSORPTION: Remove contaminated clothing. Flush thoroughly with mild soap and water. If irritation occurs, get medical attention.

Section 5 Fire Fighting Measures

Suitable Extinguishing Media: Use any media suitable for extinguishing supporting fire.

Protective Actions for Fire-fighters: In fire conditions, wear a NIOSH/MSHA-approved self-contained breathing apparatus and full protective gear. Use water spray to keep fire-exposed containers cool.

Specific Hazards: During a fire, irritating and highly toxic gases may be generated by thermal decomposition or combustion.

Section 6 Accidental Release Measures

Personal Precautions: Evacuate personnel to safe area. Use proper personal protective equipment as indicated in Section 8. Provide adequate ventilation.

Environmental Precautions: Avoid runoff into storm sewers and ditches which lead to waterways.

Containment and Cleanup: Absorb with inert dry material, sweep or vacuum up and place in a suitable container for proper disposal. Wash spill area with soap and water.

Section 7 Handling and Storage

Precautions for Safe Handling: Read label on container before using. Do not wear contact lenses when working with chemicals. Keep out of reach of children. Avoid contact with eyes, skin and clothing. Do not inhale vapors, spray or mist. Use with adequate ventilation. Avoid ingestion. Wash thoroughly after handling. Remove and wash clothing before reuse.

Conditions for Safe Storage: Store in a cool, well-ventilated area away from incompatible substances.

Section 8 Exposure controls / Personal Protection

Exposure Limits:	Chemical Name	ACGIH (TLV)	OSHA (PEL)	NIOSH (REL)
	Potassium chloride	None established	None established	None established

Engineering controls: Facilities storing or utilizing this material should be equipped with an eyewash facility and a safety shower and fire extinguishing material. Personnel should wear safety glasses, goggles, or faceshield, lab coat or apron, appropriate protective gloves. Use adequate ventilation to keep airborne concentrations low.

Respiratory protection: None should be needed in normal laboratory handling at room temperatures. If misty conditions prevail, work in fume hood or wear a NIOSH/MSHA approved respirator.

Section 9 Physical and Chemical Properties

Appearance: Clear, colorless liquid. Odor: No odor. Odor threshold: Data not available. pH: 10.0 Melting/Freezing point: Approx. 0°C (32°F) (water) Boiling point: Approx. 100°C (212°F) (water) Flash point: Data not available	Evaporation rate (Water = 1): <1 Flammability (solid/gas): Data not available. Explosion limits: Lower/Upper: Data not available Vapor pressure (mm Hg): 14 (water) Vapor density (Air = 1): 0.7 (water) Relative density (Specific gravity): Approx. 1.0 (water) Solubility(ies): Complete in water.	Partition coefficient: Data not available Auto-ignition temp.: Data not available Decomposition temp.: Data not available Viscosity: Data not available. Molecular formula: Mixture Molecular weight: Mixture
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Section 10 Stability and Reactivity

Chemical stability: Stable **Hazardous polymerization:** Will not occur.

Conditions to avoid: Excessive temperatures which cause evaporation.

Incompatibilities with other materials: Acids, alkalies, and air will change the buffer's ability.

Hazardous decomposition products: Boron oxide and chlorine gas.

Section 11 Toxicological Information

Acute toxicity: Data not available Serious eye damage/irritation: Data not available Germ cell mutagenicity: Data not available	Skin corrosion/irritation: Data not available Respiratory or skin sensitization: Data not available Carcinogenicity: Data not available
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NTP: No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.

IARC: No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.

OSHA: No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.

Reproductive toxicity: Data not available Aspiration hazard: Data not available	STOT-single exposure: Data not available STOT-repeated exposure: Data not available
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Potential health effects:

- Inhalation: May be harmful if inhaled.
- Ingestion: May be harmful if swallowed.
- Skin: May cause mild irritation.
- Eyes: May cause mild irritation.

Signs and symptoms of exposure: To the best of our knowledge the chemical, physical and toxicological properties have not been thoroughly investigated. Specific data is not available. Exercise appropriate procedures to minimize potential hazards.

Additional information: RTECS #: Data not available

Section 12 Ecological Information

Toxicity to fish: No data available Toxicity to daphnia and other aquatic invertebrates: No data available Toxicity to algae: No data available Persistence and degradability: No data available Mobility in soil: No data available	Bioaccumulative potential: No data available PBT and vPvB assessment: No data available
Other adverse effects: An environmental hazard cannot be excluded in the event of unprofessional handling or disposal.	

Section 13 Disposal Considerations

These disposal guidelines are intended for the disposal of catalog-size quantities only. Federal regulations may apply to empty container. State and/or local regulations may be different. Dispose of in accordance with all local, state and federal regulations or contract with a licensed chemical disposal agency.

Section 14 Transport Information

UN/NA number: Not applicable Hazard class: Not applicable Exceptions: Not applicable	Shipping name: Not Regulated Packing group: Not applicable 2012 ERG Guide # Not applicable	Reportable Quantity: No	Marine pollutant: No
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Section 15 Regulatory Information

A chemical is considered to be listed if the CAS number for the anhydrous form is on the Inventory list.

Component	TSCA	CERLCA (RQ)	RCRA code	DSL	NDSL	WHMIS Classification
Potassium Chloride	Listed	Not Listed	Not Listed	Listed	Not Listed	Uncontrolled Product
Sodium hydroxide	Listed	1,000 lbs (454 kg)	D002	Listed	Not Listed	E

Section 16 Additional Information

The information contained herein is furnished without warranty of any kind. Employers should use this information only as a supplement to other information gathered by them and must make independent determinations of suitability and completeness of information from all sources to assure proper use of these materials and the safety and health of employees.

NTP: National Toxicology Program, IARC: International Agency for Research on Cancer, OSHA: Occupational Safety and Health Administration, STOT: Specific Target Organ Toxicity, SE: Single Exposure, RE: Repeated Exposure, ERG: Emergency Response Guidebook.