1000 How Poisons Work

This kit focuses on the mechanism of enzyme activity, and how poisons affect that activity. The materials provided in this kit allow up to 15 pairs of students to observe the following reactions:

- the enzymatically catalyzed breakdown of hydrogen peroxide into oxygen gas and water
- the breakdown of starch into glucose as catalyzed by amylase
- the effects of metal poisons on the above reactions
- a comparison between organically and inorganically catalyzed reactions, and their sensitivities to poisons.

The material is suited for high school or advanced junior high school classes of chemistry and biology. The experiments can be performed in one to two 45 minute class periods.

Contents:

LabForms (15)
Razor Blades (15)
Pipets (17)
Chemstrips (1 package)
Dilute solutions of:
- Hydrogen Peroxide (2 - 120 ml bottles)
- Lead Nitrate (2 - 30 ml bottles)
- Mercuric Nitrate (2 - 30 ml bottles)
- Lugol's Solution (2 - 30 ml bottles)
- Hydrochloric Acid (1 - 60 ml bottle)

Dextrose Powder (4 grams)
Manganese Dioxide (15 grams)
Starch Powder (3 grams)

Teacher Manual (1)
Student Instructions (1 Master)

Additional Required Materials:

Fresh Potato
Styrofoam Cups
Warm Water
Saliva Samples
Teaspoons

HOW POISONS WORK #1000 Teacher Manual

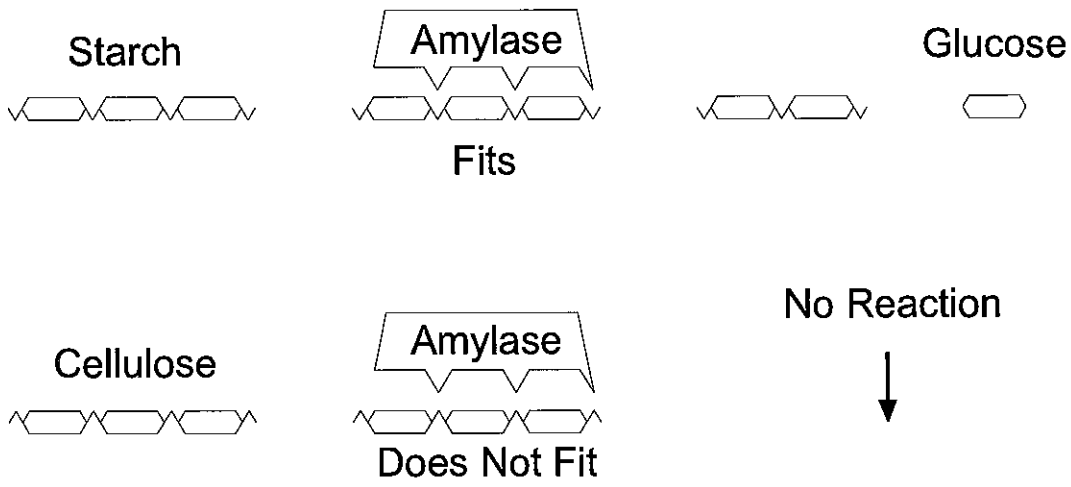
Introduction

All life depends on a variety of organic catalysts called enzymes. Many Nobel Prize-winning studies in recent years have been on the structure and activity of these agents. The expanding field of genetic engineering is also largely concerned with their activity and structure. Many of the factors which influence enzyme activity have been areas of social concern as well. Many genetic disorders are characterized by particular enzyme malfunctions. Malnutrition deprives the body of essential building blocks and activators necessary for their production. Our environment has become polluted with a variety of chemicals that directly affect the action of enzymes. This kit focuses on the mechanism of enzyme activity, and the effect poisons have on that activity. This kit is designed to be used by secondary level biology students, and is probably best used along with class discussions of enzyme activity, metabolic disorders, or pollution. The topics of enzyme-catalyst, active site, substrate, and enzyme structure are introduced to explain the laboratory results.

Background Information

The modern theory of enzyme action is often called the "Lock and key" theory. Enzymes are proteins with complex molecular structures. Substrates, the enzyme's target molecules, must fit into the three-dimensional structure of the enzyme, much as a key fits into a lock. The substrate is held to or within the enzyme by loose chemical attractions, such as hydrogen bonds. Although enzymes are large molecules, only a small portion of the enzyme contacts the substrate. This region, the *active site*, consists of a group of amino acids from the protein chain of the enzyme. The various amino acids are oriented so that the substrate can first bind and then be converted to the desired products. The final product is then released by the enzyme, which returns to its original structure. Since the structure of the active site is so precise, each enzyme can act on only one type of substrate molecule. In the same way that only one key will fit a lock, of two similar substrate molecules only one has the precise fit required for reaction to occur. This property of enzymes is called their *specificity*.

The specificity of enzymes is illustrated schematically in Figure 1:

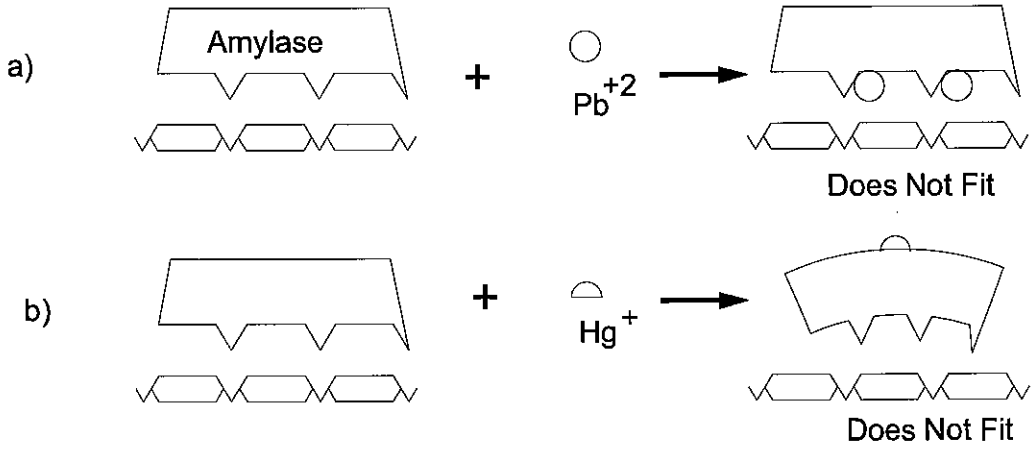


In this representation, the enzyme amylase catalyzes the removal of a glucose molecule from the end of a molecule of starch. The active site of the amylase molecule fits into the starch substrate, allowing reaction to occur. By contrast, a molecule of cellulose does not fit into the active site of amylase, and the reaction does not occur. Although cellulose and starch are both long chains of glucose molecules, they have different bonds between the sugar units. This slight difference is sufficient to make cellulose an unacceptable substrate for amylase. This is the reason that we cannot get energy by eating wood - our amylase enzymes will not catalyze the breakdown of the cellulose in wood.

Blocking Enzyme Activity - Poisons

Every one of the thousands of reactions that occur in our bodies depends on enzymes. If the activity of a particular enzyme is blocked in some way, the result may be serious. Many genetic diseases result from "faulty" enzymes that do not have the correct amino acids needed for a functional active site. The reaction that would have been catalyzed by the enzyme will not occur.

Even if the enzyme itself is normal, its activity may be blocked by various kinds of poisons. Poisons act on enzymes in two basic ways: by becoming locked into the active site of an enzyme, preventing it from acting on the correct substrate, or by changing the shape of the enzyme, thereby deactivating the active site. The first type of poison is typified by heavy metal ions, such as mercury, Hg^{+}, or lead, Pb^{+2}. Considerable attention has been given recently to the harmful effects of mercury and lead pollution. Figure 2 shows schematically how lead might affect the action of the amylase enzyme. While not all heavy metals attach directly to the active site, Pb^{+2} is shown in the active site in Figure 2a to illustrate how the metal ion prevents the enzyme from attaching correctly. Figure 2b shows how a Hg^{+} ion might attach to part of the enzyme other than the active site, indirectly affecting the active site.



Another example of the first type of poison is the arsenate ions, AsO_4^{-3}, which are chemically similar to phosphate ions. The phosphate ion, PO_4^{-3}, is involved in many important reactions involving enzymes. The arsenate ion, if present, will fill the active site normally occupied by a phosphate ion, and remain bonded there. The enzyme is prevented from acting on the phosphate ions.

Using The Kit In The Classroom

Objectives:

This kit allows the student to:

- Observe two enzymatically-catalyzed reactions, and measure the rates of reaction using appropriate techniques.
- Observe the effects of metal poisons on the two reactions, and to describe the decrease in reaction rate in terms of enzymes, substrate, active site, and catalysis.
- State at least one reason why lead and mercury are considered harmful pollutants in rivers, streams, etc.

The two enzymatic reactions to be studied are: 1) the breakdown of hydrogen peroxide into water and oxygen gas catalyzed by the enzyme *peroxidase* found in potatoes and 2) the breakdown of starch into glucose catalyzed by salivary *amylase*. The rate of the peroxidase/H_2O_2 reaction will be measured by observing the rate of bubbling (oxygen production) in the solution. Differences in rates will be measured on a qualitative basis (faster or slower bubbling) rather than a quantitative measurement. Throughout the activity, you may wish to discuss possible means of taking quantitative measurements, and what those measurements might show about the system being studied. The rate of the amylase/starch reaction will be measured using the iodine-potassium iodide test for starch, also a qualitative test, and the Chemstrip test for the presence of glucose, a quantitative test. (Chemstrips may be used by diabetics to test for the presence of sugar in urine.)

Preparing The Materials

Make up the starch and glucose (dextrose) solutions by mixing the packets of starch and dextrose powder with 250ml of warm water (use distilled water, if possible). Use the pipets provided to dispense the solutions. Have a fresh potato available as well.

Guide To The Student Materials

Prior to beginning the labs, you should provide an introduction to both inorganic and organic catalysis of chemical reactions. Concentrate on enzyme activity, specificity, and the actions of poisons such as described in the Background Information section of this Teacher's Manual. Also, discuss the topic of inorganic vs. organic catalysis, giving the advantages and disadvantages of enzyme specificity and sensitivity as compared to inorganic catalyst's generality and insensitivity. Such an introduction will make the purposes of the various lab procedures clearer to the students.

Part A: Peroxidase/H_2O_2 Reaction:

This section of the lab procedures deals with hydrogen peroxide's decomposition into water and oxygen in the following reaction:

$$2H_2O_2 \rightarrow 2H_2O + O_2\uparrow$$

The first step in this procedure establishes the fact that hydrogen peroxide does not decompose significantly under normal conditions. When the potato, which contains the enzyme *peroxidase*, is added, the rate of decomposition is greatly increased. (If you wish to demonstrate the oxygen production, set up a 250 ml Erlenmeyer flask with a large amount of peroxide solution and potato, and use the glowing splint test.) In the second step, the drastic reduction of oxygen production after the addition of mercury ions establishes mercury as a poison. Try to relate these results to the question of mercury pollution, and its effects on a wide variety of organisms.

Dispose of the waste water in a glass container and keep this container available for the disposal of Part B waste products.

Part B: Starch/Amylase

This section deals with the breakdown of starch into sugar (glucose) by an enzyme called amylase that is found in saliva. Diagrams of the reaction are in the Background Information section of the Teacher's Manual.

The first step in the procedure establishes the use of Lugol 's solution (iodine-potassium) as a test for starch.

The second step develops the use of Chemstrips as a test for the presence of sugar. Point out to the students that Chemstrips are used by diabetics to test for sugar in urine, and be sure that the students are able to use the color scale on the package correctly.

The third step establishes the following points:

- Saliva contains no starch or sugar (note: if the students have eaten just prior to this experiment, their saliva may test positive for sugar)
- The amount of starch in solution will decrease when saliva is added, as shown by the lighter color with the iodine solution
- Sugar is produced as the amylase acts on the starch

The fourth step shows that lead ion decreases the activity of amylase. Point out to the students that the solution of lead is quite dilute, yet it has a tremendous effect on the enzymes activity. Relate the effect of the lead to its alteration of the active site of the enzyme. Make sure that the students pour their waste materials into the glass container set aside for this purpose.

Try to develop the idea that there are thousands of enzymes besides amylase which will react in a similar way to the presence of lead. Lead poisoning is extremely serious, especially in large urban areas. In addition to the many deaths which lead-based paint has caused, children and adults have suffered serious brain, heart, and liver damage.

Part C: Organic And Inorganic Catalysts

The last set of experiments compares the action of enzymes with inorganic catalysts, demonstrating that poisons and pH changes do not affect inorganic catalysts as much as they do enzymes. The powdered manganese dioxide and the potato enzyme peroxidase will both catalyze the breakdown of hydrogen peroxide.

Step one establishes the fact that both the enzyme and the manganese dioxide both catalyze the breakdown of hydrogen peroxide. Step two demonstrates the organic catalyst's sensitivity and the inorganic catalyst's insensitivity to pH changes. The enzyme's sensitivity and the manganese dioxide's insensitivity to the poison lead ions is shown in Step 3. This should be related to the overall properties of enzymes as compared with

inorganic catalysts.

Disposal of the waste from these activities can be developed into a very interesting discussion of pollution, and man's effect on his environment. Hopefully, the students will point out the danger of pouring the lead solution down the drain. Develop the need to dispose of the waste in a way which will not introduce the poison to the water/waste system. The glass container filled with the waste from all classes should be disposed of according to state or local regulations. An additional disposal method involves precipitating out the soluble lead and mercury ions with a concentrated sodium chloride or sodium sulfide solution. By adding a small amount of either solution to the waste container, one can insure that the lead and mercury ions will not diffuse into the environment.

Topics For Discussion

After completing the kit several areas may be discussed:

1 Discuss enzymes in more detail, concentrating on such features as their protein composition, structure, origin in the cell, sensitivity, etc.

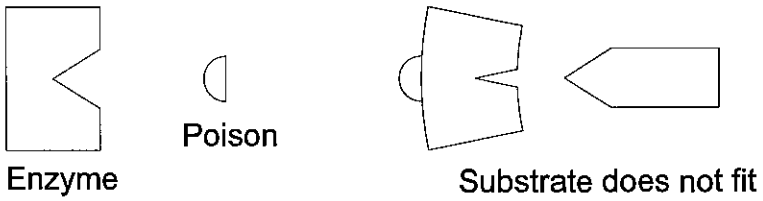
2 Discuss various types of poisons and their target enzymes in organisms. Insecticides and nerve gases act on the enzyme cholinesterase in the nervous system. These poisons prevent the enzyme from breaking down acetylcholine, which in turn causes repeated nerve impulses, muscle spasms, and death. Relate the mechanism by which poisons act to other chemicals such as penicillin, which fills the active site of a certain bacterial enzyme.

3 Discuss the various sources of pollution. Lead is a common by-product of paint and petroleum industries, while mercury is often produced by paper manufacturing plants. Discuss problems of waste disposal as a large-scale industrial problem, and develop the need to find efficient, yet inexpensive, disposal procedures.

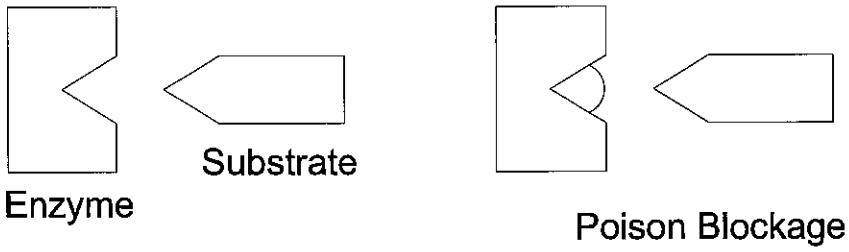
HOW POISONS WORK #1000 Student Instructions (annotated)

All life depends on the correct functioning of many different enzymes. Enzymes catalyze, or help along, specific reactions within the body. These enzymes are proteins that have complex structures with one specific area, the *active site*, that is designed to fit the *substrate* molecule exactly. The substrate, the molecule on which the enzyme will act, fits into the enzyme much like a key fits into a lock. Only one key will open a lock, and only one substrate will fit into an enzyme. The enzyme then catalyzes the reaction and releases the end product.

This kit is designed to show you how *poisons* work. Poisons can act on enzymes in two different ways. First, they can act by somehow changing the shape of the active site of the enzyme so that the substrate cannot fit properly.



Second, they may have a very similar structure to the substrate molecule and compete with the proper substrate for the enzyme active site.



If the substrate cannot fit into the active site, then no reaction occurs, and the enzyme is deactivated. Mercury is a terrible poison. It is used to make batteries, paints, electrical switches and hundreds of products. Incineration of these items releases mercury into the atmosphere where it can remain for up to two years. At any one time the atmosphere contains 930 tons of this deadly material which slowly descends in rain and snow upon wildlife and

man.

Mercury has been linked to the deaths of panthers and loons in Florida and is suspected in the reproductive failures of eagles and minks of the Great Lakes Region. In the 1950's and early 1960's more than 100 people fell into comas and died in Minamata, Japan. The tragedy was linked to their diet of fish, heavily contaminated with mercury. Amounts of the toxin which are less than fatal result in slurred speech, mental dysfunction, and uncontrollable shaking.

PART A: Breakdown of Hydrogen Peroxide By Peroxidase

Many animal and plant materials contain an enzyme called *peroxidase*. This enzyme can catalyze the breakdown of hydrogen peroxide into water and oxygen:

$$2H_2O_2 \rightarrow O_2\,(gas) + 2H_2O$$

This reaction can be observed by measuring the rate at which bubbles of oxygen are produced. Under normal conditions, the reaction is very slow, but in the presence of a material such as potato or liver, a high rate of reaction can be observed.

Place 2 ml (about two cm [1 in] high in the LabForm tube) of hydrogen peroxide solution in tube A of the LabForm. (*CAUTION: hydrogen peroxide can be harmful to the skin. so use careful technique during this part of the activity.*) Add a small piece of potato to the tube and record your observations.

After the potato is added, small bubbles rise from the surface of the potato; these continue at a relatively constant rate for several minutes.

Place 2 ml of peroxide solution in tube C of the LabForm. Add 2 drops of the mercury nitrate solution, then add another piece of potato to this tube. Record your results.

No bubbles or very few bubbles form in this case.

What effect does the mercury have on the activity of the peroxidase enzyme?

The mercury has apparently destroyed the ability of the peroxidase to breakdown the hydrogen peroxide. (Try to get the students to discuss the dangers of mercury)

Dispose of the reagents as your teacher instructs.

PART B: Starch/Salivary Amylase

Your saliva contains an enzyme called *amylase* which can break down starch into sugar. In this experiment, you will first measure the activity of amylase, and then test the effect of the poison, lead. Before beginning the experiment, saliva must be collected from either you or your partner in one of the small plastic cups provided.

Using a pipet, place 2 ml (a 2 ml point is marked on the pipet) of starch solution in tube A of the LabForm. With another pipet, place 2 ml of glucose solution in tube C. Add 2 drops of iodine solution to each of the tubes. Record any color changes below

Iodine plus starch turns bluish or dark purple. The glucose solution shows only the brownish yellow of the iodine solution

The color which you observed in tube A is a standard test for the presence of *starch.*

Using the starch pipet, place one drop of starch solution on the reagent end of a Chemstrip and, using the glucose (dextrose) pipet, one drop of glucose solution on another Chemstrip. Let each Chemstrip set for 1-2 minutes. Chemstrips will indicate the presence of glucose. Compare the colors with those on the case of the Chemstrips. Does starch contain any sugar which can be detected by the Chemstrip?

No (NOTE: if you heat the starch solution excessively in preparation, or let it sit for long periods of time, the test may be positive)

Using another pipet, place about 1 ml of saliva in tubes B, E, and G of the LabForm. Add 2 drops of the iodine solution to tube B and record the results.

Does saliva contain detectable starch?

No

Dip the reagent end of a Chemstrip into tube B containing the saliva/starch solution. Remove and let Chemstrip set for 1-2 minutes. Compare the Chemstrip with the color on the package. Does saliva contain any detectable sugar?

No (NOTE: if the students have just eaten, saliva may show detectable sugar)

Place 2 ml of starch solution in tubes E and G, and allow the mixtures to sit for 5 minutes. If it is available, immerse the LabForm in a styrofoam cup with warm water (Not hot) about 2/3 full. Warmth keeps the saliva at body temperature. After 5 minutes, add 2 drops of iodine solution in tube E and dip a Chemstrip into tube G. Let the Chemstrip set for 1-2 minutes. Record the results.

Tube E should show a less positive reaction for the starch, as compared with Tube A, and some sugar should be present in tube G.

What did the saliva do to the starch solution?

Saliva has, in some way, broken down the starch and created sugar. In fact the starch is digested into sugar molecules.

Clean out the LabForm, and place about 1 ml of saliva in tube A. Add 2 drops of the lead nitrate solution to the tube, then add 2 ml of starch solution. After 5 minutes, test the solution with a Chemstrip and record the results. What has the lead done to the activity of the amylase?

The Chemstrip should show no sugar produced. The lead prevented the saliva from performing its normal function.

Disposeof the reagents as your teacher instructs.

Until about 10 years ago, many houses, especially in cities, were being painted with lead-based paint. A particular danger is painting over existing paint. Even though non-leaded paint is now used, the old paint underneath still has lead pigments present. While the surface coat may be non-leaded, if it chips, the paint underneath may be exposed and may be eaten by children. (This paint has a mildly sweet taste). About 5% of children living in low-income urban areas suffer from some symptoms of lead poisoning.

Place 1 ml of saliva in Tube B the LabForm. Add 5 drops of hydrochloric acid to the saliva, then add 2 ml of starch solution. After 5 minutes, test the solution with a Chemstrip, and record the results.

The Chemstrip should show no glucose produced.

The saliva has been deactivated by the hydrochloric acid. Since enzymes are proteins, they are very sensitive to changes in the pH of their environment.

PART C: Organic Versus Inorganic Catalysts

Enzymes are *organic* molecules that catalyze specific chemical reactions in the body. To achieve this specificity (the ability to act on one type of molecule), enzymes are often very complex and fragile molecules. Other molecules can catalyze the same reactions as enzymes, and are much less susceptible to environmental changes and poisons. These *inorganic* molecules, though, lack specificity, and will act on very large numbers of different types of molecules.

We already know from Part A that an enzyme in potatoes, peroxidase, will catalyze the breakdown of hydrogen peroxide into water and oxygen. In this section, we will compare the effect of pH change and lead poisoning on this organic peroxidase enzyme and another, inorganic, catalyst called manganese dioxide.
Look back to Part A and record your results from putting potato pieces into hydrogen peroxide:

The hydrogen peroxide bubbled when the potato was put in it.

Get another small piece of potato (about 2 cm^2 is plenty), and cut it up into small pieces. Pour 1 ml (1 cm) of hydrogen peroxide into tubes A and C of the LabForm. Add 5 drops of hydrochloric acid to tube A, and some cut up potato. Record the results:

The hydrogen peroxide bubbled little or not at all.

To tube C of the LabForm, add 5 drops of lead nitrate, and then a small amount of potato. Record your results.

The hydrogen peroxide bubbled little or not at all.

Manganese dioxide is an example of one of these nonspecific inorganic catalysts. We have just used potatoes containing the enzyme peroxidase to catalyze the breakdown of hydrogen peroxide. Manganese dioxide catalyzes the same reaction. After rinsing it thoroughly, place 1 ml of hydrogen peroxide in tube A, C, and E of the LabForm. Add a sprinkle (about 1/8 teaspoon) of manganese dioxide to tube A and record the results.

The hydrogen peroxide bubbles (and turns steel grey).

Add 5 drops of hydrochloric acid to the hydrogen peroxide in tube C, then add a small amount of manganese dioxide to tube C. Record the results.

The hydrogen peroxide bubbles (and turns steel grey).

Add 5 drops of lead nitrate to tube E of the LabForm, and then the same amount of manganese dioxide as used before. Record the results.

The hydrogen peroxide bubbles (and turns steel grey).

Dispose of the lead nitrate solutions from the Labform as your teacher instructs.

Questions For Discussion

1 Some poisons, like mercury, can effect the activity of a large number of different enzymes. Others, like nerve gases, will effect only a particular enzyme. Explain.

The heavy metal poisons deactivate enzymes by binding on the enzyme molecules. They can bind on to many different protein molecules, including enzymes. Nerve gas and other poisons are similar in structure to the substrate molecules on which the enzyme is supposed to be acting. Since enzymes are specific in their activity, the poison is able to mimic the substrate for only particular enzymes.

2 Why do you think that living things rely on enzymes to catalyze reactions rather than the heartier inorganic catalysts, which are not effected by temperature, poisons, or acidity changes to any great extent.

Since life requires a precise balance of a wide variety of chemicals, it's important for an organism to have a mechanism for controlling each of the chemicals carefully. Enzymes provide this fine control because of their specificity, they act on specific molecules for which they have the correct active site structure. Inorganic catalysts tend to be much less specific in their activity. Also, the cell can control the amount of each enzyme which is produced, which provides yet another level of control.

3 Discuss the effects of a factory dumping large amounts of mercury into the river from which it draws water.

The algae and protozoa which live in the water would either die or accumulate high levels of mercury. Larger organisms which feed on these small ones would then suffer the loss of their food supply, would in turn accumulate high levels of mercury, or would die. Eventually humans might eat the toxic fish and become poisoned by this heavy metal, which causes mental and personality changes marked by depression, among other physical effects. The effects of water pollution can be felt many miles downstream from the point of pollution, and great distances inland as well. Just as the life of an individual organism is a sensitive balance, so is the life of a community of organisms.

NOTE - In Minamata, a small fishing village in Japan, in the early 1950's, there was an outbreak of mercury poisoning. The disease showed in lesions of the central nervous system causing progressive weakening of the muscles, loss of vision, impairment of the cerebral functions, eventual paralysis, and sometimes death. Many of the areas sea birds also showed signs of mercury poisoning. This led to the discovery of high concentrations of methyl mercurials in fish and shellfish taken from the bay. The source of mercury was traced to the effluent from a factory.

4 If you have access to biology reference texts, discuss the means by which enzymes are produced in the cell.

Genetic information is contained in molecules of DNA found in the nucleus of the cell. This genetic "code" is transferred to a similar molecule, RNA. The code is "read" on specialized structures called ribosomes. The code determines a specific sequence of amino acids, which are the components of proteins. In this way, the cell manufacture's the enzymes it needs.

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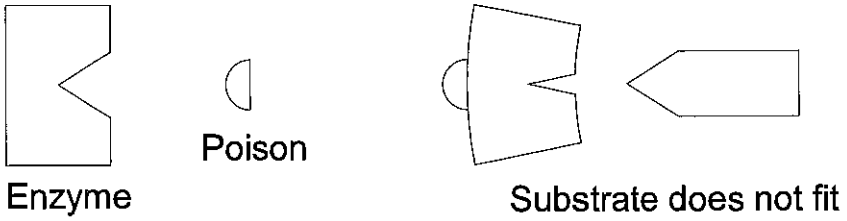

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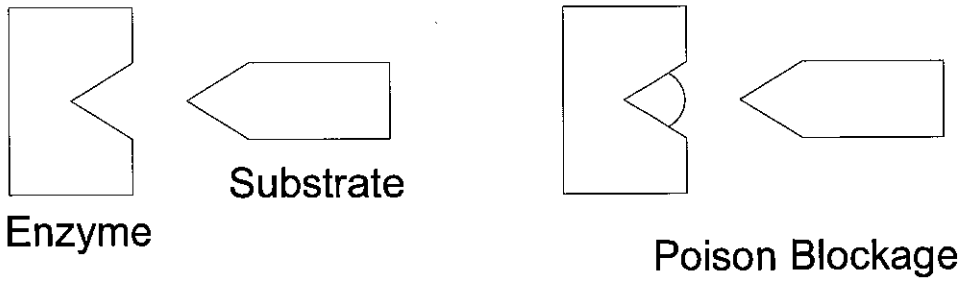

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This reaction can be observed by measuring the rate at which bubbles of oxygen are produced. Under normal conditions, the reaction is very slow, but in the presence of a material such as potato or liver, a high rate of reaction can be observed.

Place 2 ml (about two cm [1 in] high in the LabForm tube) of hydrogen peroxide solution in tube A of the LabForm. (*CAUTION: hydrogen peroxide can be harmful to the skin. so use careful technique during this part of the activity.*) Add a small piece of potato to the tube and record your observations.

Place 2 ml of peroxide solution in tube C of the LabForm. Add 2 drops of the mercury nitrate solution, then add another piece of potato to this tube. Record your results.

What effect does the mercury have on the activity of the peroxidase enzyme?

Dispose of the reagents as your teacher instructs.

PART B: Starch/Salivary Amylase

Your saliva contains an enzyme called *amylase* which can break down starch into sugar. In this experiment, you will first measure the activity of amylase, and then test the effect of the poison, lead. Before beginning the experiment, saliva must be collected from either you or your partner in one of the small plastic cups provided.

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Using the starch pipet, place one drop of starch solution on the reagent end of a Chemstrip and, using the glucose (dextrose) pipet, one drop of glucose solution on another Chemstrip reagent pad. Let the Chemstrips set for 1-2 minutes. Chemstrip will indicate the presence of glucose. Compare the colors with those on the case of the Chemstips. Does starch contain any sugar which can be detected by the Chemstrips?

Using another pipet, place about 1 ml of saliva in tubes B, E, and G of the LabForm. Add 2 drops of the iodine solution to tube B and record the results.

Does saliva contain detectable starch?

Dip the reagent end of a Chemstrip into tube B containing the saliva/starch solution. Remove the Chemstrip and let set 1-2 minutes. Compare the strip with the color on the package. Does saliva contain any detectable sugar?

Place 2 ml of starch solution in tubes E and G, and allow the mixtures to sit for 5 minutes. If it is available, immerse the LabForm in a styrofoam cup with warm water (Not hot) about 2/3 full. Warmth keeps the saliva at body temperature. After 5 minutes, add 2 drops of iodine solution in tube E and dip a Chemstrip into tube G. Remove strip and wait 1-2 minutes. Record the results.

What did the saliva do to the starch solution?

Clean out the LabForm, and place about 1 ml of saliva in tube A. Add 2 drops of the lead nitrate solution to the tube, then add 2 ml of starch solution. After 5 minutes, test the solution with a Chemstrip and record the results. What has the lead done to the activity of the amylase?

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The saliva has been deactivated by the hydrochloric acid. Since enzymes are proteins, they are very sensitive to changes in the pH of their environment.

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Get another small piece of potato (about 2 cm^2 is plenty), and cut it up into small pieces. Pour 1 ml (1 cm) of hydrogen peroxide into tubes A and C of the LabForm. Add 5 drops of hydrochloric acid to tube A, and some cut up potato. Record the results:

To tube C of the LabForm, add 5 drops of lead nitrate, and then a small amount of potato. Record your results.

Manganese dioxide is an example of one of these nonspecific inorganic catalysts. We have just used potatoes containing the enzyme peroxidase to catalyze the breakdown of hydrogen peroxide. Manganese dioxide catalyzes the same reaction. After rinsing it thoroughly, place 1 ml of hydrogen peroxide in tube A, C, and E of the LabForm. Add a sprinkle (about 1/8 teaspoon) of manganese dioxide to tube A and record the results.

Add 5 drops of hydrochloric acid to the hydrogen peroxide in tube C, then add a small amount of manganese dioxide to tube C. Record the results.

Add 5 drops of lead nitrate to tube E of the LabForm, and then the same amount of manganese dioxide as used before. Record the results.

Questions For Discussion

1 Some poisons, like mercury, can effect the activity of a large number of different enzymes. Others, like nerve gases, will effect only a particular enzyme. Explain.

2 Why do you think that living things rely on enzymes to catalyze reactions rather than the heartier inorganic catalysts, which are not effected by temperature, poisons, or acidity changes to any great extent.

3 Discuss the effects of a factory dumping large amounts of mercury into the river from which it draws water.

4 If you have access to biology reference texts, discuss the means by which enzymes are produced in the cell.

SAFETY INSTRUCTIONS: IMPORTANT

NOTICE TO TEACHERS REGARDING LABORATORY REAGENTS

Perhaps the best general rule regarding the safe handling of laboratory chemicals is to treat all of them as being potentially dangerous. This means that none of them should be taken internally, and that any external contact should be washed thoroughly. In fact, most of the chemicals provided in The Science Source kits are diluted enough that they are not hazardous. The following lists indicate appropriate antidotes for the hazardous chemicals. Check this list for the chemicals provided in the kit:

I. **Concentrated Acids & Bases** - **Do not** induce vomiting, dilute with water, then milk or egg white, call a physician immediately.

1. 25 % Acetic Acid
2. 3M Hydrochloric Acid
3. Concentrated Sulfuric Acid

II **Dilute Acids & Bases** - **Dilute** with water, then milk.

1. 1 M, 0.5M, 0.1 M Hydrochloric Acid
2. Oxalic Acid
3. Sodium Hydroxide
4. Ammonium Hydroxide

III **Miscellaneous Chemicals** - Dilute immediately with water. Induce vomiting with warm salt water, or warm baking soda solution.

1. Ammonium Chloride
2. Ammonium Oxalate
3. Barium Chloride
4. Biuret Reagent
5. Bromthymol Blue
6. Calcium Chloride
7. Ethanol (Denatured Alcohol)
8. Ferric Ammonium Sulfate
9. Hydrogen Peroxide
10. Janus Green B
11. Lead Nitrate
12. Lugol's Solution
13. Magnesium Reagent (Titan Yellow, Alcohol)
14. Mercuric Nitrate
15. Methylene Blue
16. Ninhydrin
17. Phosphorus Reagent (Ammonium Molybdate, Nitric Acid)
18. Potassium Ferricyanide
19. Potassium Permanganate
20. Silver Nitrate
21. Sodium Carbonate
22. Sodium Thiosulfate
23. Sudan IV

IV. **Organic Solvents** - **Do not** induce vomiting. Dilute with water and milk. Call a physician immediately.

Isopropyl Alcohol

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MSDS No. HH 180
Effective Date December 10, 1996

SECTION I NAME

Product	HYDROGEN PEROXIDE 3%
Chemical Synonyms	Hydrogen Peroxide 3%
Formula	Mixture.
Unit Size	up to 4 Lt.
C.A.S. No.	Mixture.

24 HOUR EMERGENCY ASSISTANCE

CHEMTREC 800-424-9300
Day 716-226-6177

NFPA HAZARD RATING (0 / 1 / 1)

HMIS *	
Health	0
Fire	0
Reactivity	1

LEAST 0 | SLIGHT 1 | MODERATE 2 | HIGH 3 | EXTREME 4

SECTION II INGREDIENTS OF MIXTURES

Principal Component(s)	%	TLV Units
Hydrogen Peroxide (Stabilized Acetanilide): (CAS No. 7722-84-1)	3%	See Section V.
Acetanilide: (CAS No. 103-84-4)	0.05%	None assigned.
Water: (CAS No. 7732-18-5)	97%	

CAUTION! IRRITANT. MAY CAUSE IRRITATION TO SKIN AND EYES ON CONTACT.

SECTION III PHYSICAL DATA

Melting Point (°F)	Approx. 0°C (32°F)	Specific Gravity (H_2O = 1)	Approx. 1.00
Boiling Point (°F)	100°C (212°F)	Percent Volatile by Volume (%)	100%
Vapor Pressure (mm Hg)	14 (water)	Evaporation Rate (Ether =1)	Greater than 1.
Vapor Density (Air=1)	0.7 (water)		
Solubility in Water	Complete.		
Appearance & Odor	Clear, colorless liquid; no odor.		

SECTION IV FIRE AND EXPLOSION HAZARD DATA

Flash Point (Method Used)	Non-flammable.	Flammable Limits in Air % by Volume	Lower	Upper
		None		
Extinguisher Media	Use water in large quantities for extinguishing supporting fire.			

SPECIAL FIREFIGHTING PROCEDURES

Use water in large amounts to fight fire in which this material is involved. In fire conditions, wear a NIOSH/MSHA-approved self-contained breathing apparatus and eye protection.

UNUSUAL FIRE AND EXPLOSION HAZARDS

Hydrogen peroxide is non-flammable, but it provides oxygen to facilitate or initiate burning of surrounding combustibles.

D.O.T. **NON-REGULATED.**

Approved by U.S. Department of Labor "essentially similar" to form OSHA-20

SECTION V HEALTH HAZARD DATA

HH 180

Threshold Limited Value

TWA: 1 ppm; 1.4 mg/m³ (Air). ACGIH 1992-93.
Material decreases in hazard as H_2O_2 concentration decreases.

Effects of Overexposure

EYES: May cause irritation on contact. SKIN: Prolonged contact with skin may produce irritation. INGESTION: May be harmful if swallowed. Exercise appropriate procedures to minimize potential hazards.

Emergency and First Aid Procedures

EYES: Flush thoroughly with water for at least 15 minutes, lifting upper and lower eyelids occasionally. Get immediate medical attention. SKIN: Flush thoroughly with water, then wash with mild soap and water. INGESTION: If swallowed, if conscious, give one or two glasses of water to drink. Call a physician. Never give anything by mouth to an unconscious person.

SECTION VI REACTIVITY DATA

Stability	Unstable		Conditions to Avoid: Stability decreased by strong sunlight, heat, mixing.
	Stable	X	

Incompatibility (Materials to Avoid): Do not add anything to this container - as violent reaction may occur. Readily reacts with reducing agents, organic materials, dirt, rust, metals.

Hazardous Decomposition Products: Decomposes to water and oxygen.

Hazardous Polymerization		Conditions to Avoid
May Occur	Will Not Occur	
	X	Not applicable.

SECTION VII SPILL OR LEAK PROCEDURES

Steps to be taken in case material is released or spilled

Dilute with water to 1% or less and flush to sewer with copious amounts of water.

Waste Disposal Method

Discharge, treatment, or disposal may be subject to Federal, State or Local laws. These disposal guidelines are intended for the disposal of catalog-size quantities only.

Dilute with water to 1% or less and flush to sewer with copious amounts of water.

SECTION VIII SPECIAL PROTECTION INFORMATION

Respiration Protection (Specify Type): None needed in normal laboratory handling. If misty conditions prevail, work in ventilation hood or wear a NIOSH/MSHA-approved respirator.

Ventilation				
Local Exhaust	None needed.	Special	No.	
Mechanical (General)	None needed.	Other	No.	

Protective Gloves	Rubber.	Eye Protection	Chemical safety glasses.

Other Protective Equipment: Smock, apron, eye wash station, goggles, proper gloves.

SECTION IX SPECIAL PRECAUTIONS

Precautions to be Taken in Handling & Storing

Keep container tightly closed when not in use.

Store in a cool, dark place. Protect from strong sunlight, reducing agents and organics. Check after one year. Beware of bulging containers, which can burst from pressure.

Other Precautions

Read label on container before using. Do not wear contact lenses when working with chemicals.

Avoid contact with eyes or prolonged contact with skin. Wash thoroughly after handling. Remove and wash contaminated clothing.

For laboratory use only. Not for drug, food or household use. Keep out of reach of children.

Revision	Date	Approved	Chemical Safety Coordinator
No. 4	12/10/96	Michael Raszeja	MR

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HH0090 HH0093
HH0094 HH0095 HH0130
HH0140 HH0150 HH0155
MSDS No.: HH0158 HH0160 HH0162
Effective Date: February 6, 2006

SECTION I NAME

24 HOUR EMERGENCY ASSISTANCE

Product	Hydrochloric Acid Solution
Chemical Synonyms	Hydrochloric Acid, Water Solution
Formula	Mixture. See Section II.
Unit Size	up to 3.785 Lt.
C.A.S. No.	Mixture. See Section II.

CHEMTREC 800-424-9300
Day 585-226-6177

NFPA: 0 (top), 3 (left), 0 (right)

HMIS *	
Health	3
Fire	0
Reactivity	2

HAZARD RATING

MINIMAL	SLIGHT	MODERATE	SERIOUS	SEVERE
0	1	2	3	4

SECTION II INGREDIENTS OF MIXTURES

Principal Component(s)	%	TLV Units
Hydrochloric Acid: (CAS No. 7647-01-0)	1.51 - 10%	See Section V.
Water: (CAS No. 7732-18-5)	90 - 98.49%	None established.
WARNING! CORROSIVE!		
HARMFUL IF SWALLOWED. IRRITANT TO EYES AND MUCOUS MEMBRANES.		

SECTION III PHYSICAL DATA

Melting Point (°F)	Freezes approx. 0°C (32°F)	Specific Gravity (H_2O = 1)	Approx. 1.0
Boiling Point (°F)	Approx. 100°C (212°F)	Percent Volatile by Volume (%)	90 - 98.49%
Vapor Pressure (mm Hg)	14 (water)	Evaporation Rate (Water =1)	Slightly less than 1.
Vapor Density (Air=1)	0.7 (water)		
Solubility in Water	Complete.		
Appearance & Odor	Clear, colorless liquid; may have acrid odor.		

SECTION IV FIRE AND EXPLOSION HAZARD DATA

Flash Point (Method Used)	Non-flammable.	Flammable Limits in Air % by Volume	Lower	Upper
		N/A		
Extinguisher Media	Use any media suitable for extinguishing supporting fire.			

SPECIAL FIREFIGHTING PROCEDURES

In fire conditions, wear a NIOSH/MSHA-approved self-contained breathing apparatus and full protective clothing.

(1996 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.7, GUIDE PAGE NO. 157)

UNUSUAL FIRE AND EXPLOSION HAZARDS

Non-combustible, but contact with common metals produce hydrogen which may form explosive mixtures with air.

D.O.T. Hydrochloric acid, 8, UN1789, PG II

Approved by U.S. Department of Labor "essentially similar" to form OSHA-20

SECTION V HEALTH HAZARD DATA HH0090

Threshold Limited Value
Hydrogen chloride as gas or fume: TWA Ceiling Limits.
TWA: 5 ppm; 7 mg/m³ (AIR). (ACGIH 2001).

Effects of Overexposure
Irritant to eyes, skin and mucous membranes. May cause burns.
Vapors may cause coughing, choking, inflammation of the respiratory tract.
May cause burns to mouth, throat, esophagus and gastrointestinal tract.
Exercise appropriate procedures to minimize potential hazards.
Target organs: Respiratory system, skin, eyes, lungs.

Emergency and First Aid Procedures
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. **EYES:** 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:** Remove contaminated clothing. Flush thoroughly with mild soap and water. If irritation occurs, get medical attention. **INHALATION:** Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.

SECTION VI REACTIVITY DATA

Stability			Conditions to Avoid
	Unstable		Excessive temperatures or heat.
	Stable	X	

Incompatibility (Materials to Avoid) Will react with most metals, alkalies, strong oxidants.

Hazardous Decomposition Products Hydrogen chloride gas may be evolved by heating. Hydrogen gas evolved by reaction with metals.

Hazardous Polymerization		Conditions to Avoid
May Occur	Will Not Occur	Not applicable.
	X	

SECTION VII SPILL OR LEAK PROCEDURES

Steps to be taken in case material is released or spilled
Carefully neutralize with sodium bicarbonate and flush to sewer with copious amounts of water.

Waste Disposal Method
Discharge, treatment, or disposal may be subject to Federal, State or Local laws. These disposal guidelines are intended for the disposal of catalog-size quantities only.
Carefully neutralize with sodium bicarbonate, soda ash, or lime and flush to sewer with copious amounts of water.

SECTION VIII SPECIAL PROTECTION INFORMATION

Respiration Protection (Specify Type) None needed in normal laboratory handling. In misty conditions work in ventilation hood or wear NIOSH/MSHA-approved respirator.

Ventilation				
	Local Exhaust	None needed.	Special	No.
	Mechanical (General)	None needed.	Other	No.

Protective Gloves	Rubber.	Eye Protection	Goggles and face shield.

Other Protective Equipment Smock, apron, eye wash station, goggles, ventilation hood, proper gloves.

SECTION IX SPECIAL PRECAUTIONS

Precautions to be Taken in Handling & Storing
Keep container tightly closed when not in use.
Store in a cool place.
Wash thoroughly after handling.

Other Precautions Read label on container before using. Do not wear contact lenses when working with chemicals. For laboratory use only. Not for drug, food or household use. Keep out of reach of children.

Remove and wash contaminated clothing.

Revision No.	Date	Approved	Chemical Safety Coordinator
5	02/06/06	James A. Bertsch	JAB

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MSDS No. MM 345
Effective Date December 18, 1996

SECTION I NAME

Product	MERCURIC NITRATE
Chemical Synonyms	Mercury (II) Nitrate
Formula	$Hg(NO_3)_2 \cdot H_2O$
Unit Size	up to 500 grams
C.A.S. No.	7783-34-8 (Monohydrate)

24 HOUR EMERGENCY ASSISTANCE

CHEMTREC 800-424-9300
Day 716-226-6177

NFPA HAZARD RATING

LEAST	SLIGHT	MODERATE	HIGH	EXTREME
0	1	2	3	4

HMIS *

Health	3
Fire	0
Reactivity	3

SECTION II INGREDIENTS OF MIXTURES

Principal Component(s)	%	TLV Units
Mercuric Nitrate	99%	See Section V.
DANGER! STRONG OXIDIZER! POISON ☠ MAY		
BE FATAL IF SWALLOWED, INHALED OR ABSORBED THROUGH		
SKIN. CONTACT WITH OTHER MATERIAL MAY CAUSE FIRE.		

SECTION III PHYSICAL DATA

Melting Point (°F)	79°C (174°F)	Specific Gravity (H_2O = 1)	4.39
Boiling Point (°F)	Decomposes.	Percent Volatile by Volume (%)	N/A
Vapor Pressure (mm Hg)	N/A	Evaporation Rate (=1)	N/A
Vapor Density (Air=1)	N/A		
Solubility in Water	Soluble.		
Appearance & Odor	White or slightly yellow, deliquescent, crystalline powder; odor of nitric acid.		

SECTION IV FIRE AND EXPLOSION HAZARD DATA

Flash Point (Method Used)	Non-flammable.	Flammable Limits in Air % by Volume N/A	Lower	Upper
Extinguisher Media	Use water spray, carbon dioxide or dry chemical.			

SPECIAL FIREFIGHTING PROCEDURES

In fire conditions, wear a NIOSH/MSHA-approved self-contained breathing apparatus and full protective clothing to prevent contact with skin and eyes. This product may ignite combustible material.

(1993 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.6, GUIDE PAGE NO. 42)

UNUSUAL FIRE AND EXPLOSION HAZARDS

Fire or excessive heat will cause mercuric nitrate to sublime, release mercury vapor or explode upon heating. Oxidizing material. In contact with easily flammable substances it may react rapidly enough to cause ignition, violent combustion or explosion. Increases the flammability of any combustible substance.

D.O.T.	MERCURIC NITRATE, 6.1, UN 1625, PG II

Approved by U.S. Department of Labor "essentially similar" to form OSHA-20

SECTION V HEALTH HAZARD DATA

MM345

Threshold Limited Value

OCCUPATIONAL EXPOSURE TO ORGANIC MERCURY [CAS No. 7439-97-6]. Recommended standard - air: TWA 0.05 mg (asHg)/m^3. Toxicity data: Oral-rat LD50: 26 mg/Kg.

Effects of Overexposure

INGESTION: Highly toxic. Mercury poisoning - may cause death if swallowed. Toxic by skin absorption. **SKIN:** May produce dermatitis and takes the form of small, discrete ulcers on the exposed parts, and is usually accompanied by conjunctivitis and inflammation of the mucous membranes of the nose and throat.

Emergency and First Aid Procedures

INGESTION: If swallowed, if conscious, give one or two glasses of water to drink, induce vomiting. Repeat until vomit fluid is clear. Call physician immediately. **SKIN:** Flush with water, then wash with mild soap and water. **EYES:** Flush thoroughly with water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention. **INHALATION AS DUST OR MIST:** Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.

SECTION VI REACTIVITY DATA

Stability			Conditions to Avoid
	Unstable		Excessive temperature and heat. Protect from light.
	Stable	X	

Incompatibility (Materials to Avoid): Reacts violently with hypophosphoric acid, unsaturates, aromatics, and phosphites Vigorous reaction with petroleum hydrocarbons, KCN, isobutene. Forms a sensitive explosive product with acetyline, ethanol, PH_3.

Hazardous Decomposition Products: Thermal decomposition or burning emits mercury vapor and oxides of nitrogen (NO_x).

Hazardous Polymerization		Conditions to Avoid
May Occur	Will Not Occur	Not applicable.
	X	

SECTION VII SPILL OR LEAK PROCEDURES

Steps to be taken in case material is released or spilled

Reclaim as much as possible. Wearing suitable protective clothing, sweep up and place in a suitable container for disposal. Neutralize contaminated area with Bicarbonate of soda. Wash spill area with soap and water. **DO NOT FLUSH TO SEWER!** Collect wash water for disposal as hazardous waste.

Waste Disposal Method: Discharge, treatment, or disposal may be subject to Federal, State or Local laws. These disposal guidelines are intended for the disposal of catalog-size quantities only.

Dispose of in accordance with federal, state and local regulations.

SECTION VIII SPECIAL PROTECTION INFORMATION

Respiration Protection (Specify Type): Work in ventilation hood. If necessary and dusty conditions prevail, wear a NIOSH/MSHA approved dusk mask. For fumes or vapor wear a NIOSH-approved respirator for mercury.

Ventilation				
	Local Exhaust	Recommended.	Special	No.
	Mechanical (General)	Recommended.	Other	No.

Protective Gloves	Rubber.	Eye Protection	Chemical safety glasses.

Other Protective Equipment: Goggles, lab coat, apron, ventilation hood, proper gloves, eye wash station.

SECTION IX SPECIAL PRECAUTIONS

Precautions to be Taken in Handling & Storing

Keep container tightly closed when not in use.

Store in a cool, dry, well-ventilated place away from ignition sources and protect from light. Keep away from combustible materials. Wash thoroughly after handling.

Other Precautions

Read label on container before using. Do not wear contact lenses when working with chemicals.

Do not breathe dust. Do not get in eyes, on skin and clothing. Decomposed by large amounts of water. May be explosive if shocked or heated. Do not flush to sewer. Remove and wash contaminated clothing.

For laboratory use only. Not for drug, food or household use. Keep out of reach of children.

Revision No. 4	Date 12/18/96	Approved Michael Raszeja	Chemical Safety Coordinator MR

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MSDS No. MM 210
Effective Date September 13, 1996

SECTION I NAME

24 HOUR EMERGENCY ASSISTANCE

CHEMTREC 800-424-9300
Day 716-226-6177

Product	MANGANESE DIOXIDE, PURE
Chemical Synonyms	Manganese Peroxide
Formula	MnO_2
Unit Size	up to 2.5 Kg.
C.A.S. No.	1313-13-9

NFPA HAZARD RATING (3, 0, 0)

	Health	Fire	Reactivity
HMIS *	3	0	0

LEAST	SLIGHT	MODERATE	HIGH	EXTREME
0	1	2	3	4

SECTION II INGREDIENTS OF MIXTURES

Principal Component(s)	%	TLV Units
Manganese Dioxide	99%	See Section V.
WARNING! STRONG OXIDIZER. HARMFUL IF SWALLOWED		
OR INHALED. CAN CAUSE NERVOUS SYSTEM INJURY.		

SECTION III PHYSICAL DATA

Melting Point (°F)	Freeze point @ 535°C (995°F)	Specific Gravity (H_2O = 1)	5.026 @ 20°C
Boiling Point (°F)	None	Percent Volatile by Volume (%)	Non-volatile.
Vapor Pressure (mm Hg)	Negligible as solid.	Evaporation Rate (n-Butyl Ac. =1)	Non-volatile.
Vapor Density (Air=1)	Data not listed.		
Solubility in Water	Insoluble in water.		
Appearance & Odor	Black/grayish silvery metallic appearance crystalline powder or granular; no odor.		

SECTION IV FIRE AND EXPLOSION HAZARD DATA

Flash Point (Method Used)	Non-flammable.	Flammable Limits in Air % by Volume	Lower	Upper
		N/A		
Extinguisher Media	Water spray; carbon dioxide (CO_2); dry chemical (ABC).			

SPECIAL FIREFIGHTING PROCEDURES

In fire conditions, wear a NIOSH/MSHA-approved self-contained breathing apparatus and full protective clothing.

(1993 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.4, GUIDE PAGE NO. 35)

UNUSUAL FIRE AND EXPLOSION HAZARDS

Moderate fire hazard, by chemical reaction; a moderate oxidizer. It must **NOT** be heated or rubbed in contact with easily oxidizable matter. At 535°C (995°F) decomposes to Mn_2O_3 and oxygen. If manganese dioxide is in contact with easily oxidizable substances, violent combustion or explosion may result upon ignition from any source. Increases the flammability of any combustible substances.

D.O.T. **Oxidizing solid, n.o.s., (Manganese dioxide), 5.1, UN 1479, PG III**

Approved by U.S. Department of Labor "essentially similar" to form OSHA-20

SECTION V HEALTH HAZARD DATA MM 210

Threshold Limited Value

TWA: As Manganese [CAS No. 7439-96-5] as manganese dust and compounds 5 mg/m³ ceiling limit (ACGIH 1992-93).

Effects of Overexposure

INHALATION: Pulmonary effects, consisting of dyspnea, shallow respiration and fever which mimic metal fume fever. Physical irritation to throat. Cold-like symptoms, chills, muscle aches, dryness of the mouth. **EYES:** May be irritating or cause mechanical injury, conjunctivitis. **SKIN:** May cause irritation, dermatitis.

Emergency and First Aid Procedures

INHALATION: Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention. **SKIN:** Flush thoroughly with water, then wash with mild soap and water. **EYES:** Flush thoroughly with water for at least 15 minutes, lifting upper and lower eyelids occasionally. Get medical attention. **INGESTION:** If swallowed, if conscious, give one or two glasses of water to drink, induce vomiting and call physician. Never give anything by mouth to an unconscious person.

SECTION VI REACTIVITY DATA

Stability		Conditions to Avoid
Unstable		Do not heat or rub with organic matter or other oxidizable substances, e.g. sulfur, sulfides, phosphides, hypophosphites, etc.
Stable	X	

Incompatibility (Materials to Avoid) Avoid contact with chlorates, chlorine, trifluoride, hydrogen peroxide, sulfuric acid, potassium azide, rubidium, ethynyl and sodium peroxide.

Hazardous Decomposition Products Heating above 535°C (995°F) will produce oxygen and Mn_2O_3. Further heating will produce manganese fume.

Hazardous Polymerization		Conditions to Avoid
May Occur	Will Not Occur	
	X	Not applicable.

SECTION VII SPILL OR LEAK PROCEDURES

Steps to be taken in case material is released or spilled

If not contaminated, recover for recycling. Sweep up and place in a suitable container for disposal.

Waste Disposal Method Discharge, treatment, or disposal may be subject to Federal, State or Local laws. These disposal guidelines are intended for the disposal of catalog-size quantities only.

Dispose of in accordance with federal, state and local regulations.

SECTION VIII SPECIAL PROTECTION INFORMATION

Respiration Protection (Specify Type) None should be needed in normal laboratory handling. If dusty conditions prevail, work in ventilation hood or wear a NIOSH/MSHA-approved dust mask or respirator.

Ventilation				
Local Exhaust	Recommended.	Special	No.	
Mechanical (General)	Recommended.	Other	No.	

Protective Gloves Rubber. **Eye Protection** Chemical safety glasses.

Other Protective Equipment Goggles, eye wash station, lab coat, fire extinguisher, proper gloves, ventilation hood.

SECTION IX SPECIAL PRECAUTIONS

Precautions to be Taken in Handling & Storing
Keep container tightly closed when not in use.

Store in a cool, dry place away from easily oxidizable materials, such as oils and grease. Wash thoroughly after handling.

Other Precautions Read label on container before using. Do not wear contact lenses when working with chemicals.

Avoid contact with eyes, skin and clothing. Use adequate ventilation. Remove and wash contaminated clothing.

For laboratory use only. Not for drug, food or household use. Keep out of reach of children.

Revision	Date	Approved	Chemical Safety Coordinator
No. 5	9/13/96	Michael Raszeja	MR

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MSDS No.: IX0162
Effective Date: August 7, 2007

SECTION I NAME

Product	Iodine-Potassium Iodide Solution
Chemical Synonyms	Iodine, Dilute Lugol's
Formula	Mixture.
Unit Size	up to 3.785 Lt.
C.A.S. No.	Mixture.

24 HOUR EMERGENCY ASSISTANCE

CHEMTREC 800-424-9300
Day 585-226-6177

NFPA

Health	3
Fire	0
Reactivity	1

HMIS *

HAZARD RATING

MINIMAL	SLIGHT	MODERATE	SERIOUS	SEVERE
0	1	2	3	4

SECTION II INGREDIENTS OF MIXTURES

Principal Component(s)	%	TLV Units
Iodine: (CAS No. 7553-56-2)	1.85%	STEL: C 0.1 ppm
Potassium iodide: (CAS No. 7681-11-0)	3.05%	None established.
Water: (CAS No. 7732-18-5)	95.1%	None established.

WARNING! CORROSIVE! HARMFUL IF INHALED OR SWALLOWED. CAUSES BURNS TO SKIN AND EYES.

SECTION III PHYSICAL DATA

Melting Point (°F)	May freeze at 0°C (32°F)	Specific Gravity (H_2O = 1)	1.0
Boiling Point (°F)	Approx. 100°C (212°F)	Percent Volatile by Volume (%)	95.1%
Vapor Pressure (mm Hg)	14 (water)	Evaporation Rate (Water =1)	Greater than 1.
Vapor Density (Air=1)	0.7 (water)		
Solubility in Water	Complete.		
Appearance & Odor	Deep-amber color liquid; iodine odor.		

SECTION IV FIRE AND EXPLOSION HAZARD DATA

			Lower	Upper
Flash Point (Method Used)	Non-flammable.	Flammable Limits in Air % by Volume N/A		
Extinguisher Media	Use any media suitable for extinguishing supporting fire.			

SPECIAL FIREFIGHTING PROCEDURES

In fire conditions, wear a NIOSH/MSHA-approved self-contained breathing apparatus and full protective clothing. Use flooding amounts of water in early stages of fire.

UNUSUAL FIRE AND EXPLOSION HAZARDS

When heated, emits toxic and corrosive, violet in color, fumes of iodine. Iodine is corrosive to metals and to all body tissues.

D.O.T. NON-REGULATED.

Approved by U.S. Department of Labor "essentially similar" to form OSHA-20

SECTION V HEALTH HAZARD DATA IX0162

Threshold Limited Value
None established for this solution. (ACGIH 2001).

Effects of Overexposure
Contact as fumes or solution is intensely irritating to eyes, skin and mucous membranes. May cause delayed lung injury. **INGESTION:** Of large quantities causes abdominal pain, vomiting and diarrhea. In severe cases purging, excessive thirst and circulatory failure may develop. Target organs: None known.

Emergency and First Aid Procedures
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. **EYES:** 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:** Remove contaminated clothing. Flush thoroughly with mild soap and water. If irritation occurs, get medical attention. **INHALATION:** Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.

SECTION VI REACTIVITY DATA

Stability		Conditions to Avoid
Unstable		Excessive temperature or heat.
Stable	X	

Incompatibility (Materials to Avoid)
Contact of gaseous ammonia or its solutions with free iodine should be avoided to prevent the formation of the explosive "nitrogen iodide". Acetaldehyde, Sodium azide, Sodium hydride.

Hazardous Decomposition Products
Free iodine.

Hazardous Polymerization		Conditions to Avoid
May Occur	Will Not Occur	Not applicable.
	X	

SECTION VII SPILL OR LEAK PROCEDURES

Steps to be taken in case material is released or spilled
Absorb spill in vermiculite, sand, earth, paper towel and place in a suitable container for disposal. Wash floor or spill area with a 5-10% Sodium thiosulfate solution.

Waste Disposal Method
Discharge, treatment, or disposal may be subject to Federal, State or Local laws. These disposal guidelines are intended for the disposal of catalog-size quantities only.

Work in a ventilation hood and wearing proper safety equipment, collect waste iodine in a large beaker. Cover with a large volume of water. Slowly add, while stirring soda ash or sodium thiosulfate till all of the iodine has been dissolved and solution is colorless. Flush to sewer with copious amounts of water.

SECTION VIII SPECIAL PROTECTION INFORMATION

Respiration Protection (Specify Type)
None should be needed in normal laboratory handling at room temperature. If needed, work in a ventilation hood.

Ventilation				
	Local Exhaust	Recommended.	Special	No.
	Mechanical (General)	Recommended.	Other	No.

Protective Gloves	Rubber.	Eye Protection	Chemical safety goggles.

Other Protective Equipment
Faceshield, mock, apron, eye wash station, ventilation hood, proper gloves.

SECTION IX SPECIAL PRECAUTIONS

Precautions to be Taken in Handling & Storing
Keep container tightly closed when not in use.
Store in a cool, dry, well-ventilated area. Remove all contaminated clothing and shoes. Wash before reuse. Wash thoroughly after handling.

Other Precautions
Read label on container before using. Do not wear contact lenses when working with chemicals. For laboratory use only. Not for drug, food or household use. Keep out of reach of children.

Avoid contact with skin,eyes and mucous membranes. Contact with skin will leave yellow iodine stain.

Revision No. 2	Date 08/17/07	Approved James A. Bertsch	Chemical Safety Coordinator JAB

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. * Hazardous Materials Industrial Standards. Printed on recycled paper.

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MATERIAL SAFETY DATA SHEET

MSDS No.: IX0160
Revision Date: April 1, 2008
Approved by: James A. Bertsch

Section 1 Chemical Product and Company Information

Product	**IODINE POTASSIUM IODIDE SOLUTION**
Synonyms	Iodine-Iodide Solution; Lugol's Dilute; Starch Test; Grams Iodine Stain

CHEMTREC 24 Hour Emergency Phone Number (800) 424-9300

Section 2 Composition / Information on Ingredients

Chemical Name	CAS #	%	TLV Units
Iodine	7553-56-2	1.85%	STEL: C 0.1 ppm
Potassium iodide	7681-11-0	3.05%	None established.
Water	7732-18-5	95.1%	None established. (ACGIH 2001)

Section 3 Hazards Identification

Emergency Overview

WARNING! CORROSIVE!
HARMFUL IF INHALED OR SWALLOWED. CAUSES BURNS TO SKIN AND EYES. Avoid contact with skin, eyes and mucous membranes.
When heated, produces iodine vapor.
Target organs: None known.

0 = Minimal
1 = Slight
2 = Moderate
3 = Serious
4 = Severe

Health	3
Fire	0
Reactivity	1
Contact	2

HMIS *

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

Section 5 Fire Fighting Measures

General information: In fire conditions, wear a NIOSH/MSHA-approved self-contained breathing apparatus and full protective gear. Use flooding amounts of water during early stages of fire. When heated, emits violet colored fumes of iodine which are toxic and corrosive to metals and all body tissues.

Extinguishing Media: Carbon dioxide, dry chemical, water spray, alcohol foam.
Flash Point: N/A
Autoignition temperature: N/A
Explosion Limits: Lower: N/A **Upper:** N/A

NFPA

0 = Minimal
1 = Slight
2 = Moderate
3 = Serious
4 = Severe

None listed.

Section 6 Accidental Release Measures

Use proper personal protective equipment as indicated in Section 8. Provide adequate ventilation. Recover for use if not contaminated. 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. Avoid runoff into storm sewers and ditches which lead to waterways.

Section 7 Handling & Storage — CORROSIVE STORAGE CODE WHITE

Read label on container before using. Do not wear contact lenses when working with chemicals. Keep container tightly closed. For laboratory use only. Not for drug, food or household use. Keep out of reach of children.
Handling: Use with adequate ventilation. Avoid contact with eyes, skin and clothing. Avoid ingestion. Do not inhale vapors, spray or mist. Wash thoroughly after handling. Remove and wash clothing before reuse.
Storage: Store in a cool, dry, well-ventilated area away from incompatible substances.

Section 8 Exposure Controls / Personal Protection

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: Use a chemical fume hood and/or wear a NIOSH/MSHA-approved respirator.

Section 9 Physical & Chemical Properties

Physical state: Liquid.
Appearance: Deep, amber color.
Odor: Iodine odor.
pH: N/A
Vapor pressure (mm Hg): 14 (water)
Vapor Density (Air = 1): 0.7 (water)
Evaporation rate (Butyl acetate = 1): < 1
Viscosity: N/A
Boiling point: ~100°C (212°F) (water)
Freezing / Melting point: ~0°C (~32°F) (water)
Decomposition temperature: N/A
Solubility: Complete.
Specific gravity (H_2O = 1): 1.0 (water)
Percent volatile (%): 95.1%
Molecular formula: Mixture.
Molecular weight: Mixture.

Section 10 Stability & Reactivity

Chemical stability: Stable
Hazardous polymerization: Will not occur.
Conditions to avoid: Excessive temperatures and heat to cause evaporation.

Incompatibilities with other materials: Contact of gaseous ammonia or its solutions with free iodine should be avoided to prevent the formation of the explosive "nitrogen iodide". Acetaldehyde, sodium azide, sodium hydride.

Hazardous decomposition products: Free iodine.

Section 11 Toxicological Information

Effects of overexposure: Contact as fumes or solution is intensely irritating to eyes, skin and mucous membranes. May cause delayed lung injury. Ingestion of large quantities of this material causes abdominal pain, vomiting and diarrhea. In severe cases, purging, excessive thirst and circulatory failure may develop.

ORL-HUM LD50: 2-4 gm as iodine
IHL-RAT LC50: N/A
SKN-RBT LD50: N/A

Section 12 Ecological Information

Data not yet available.

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: N/A
Shipping name: **Not Regulated.**
Hazard class: N/A
Packing group: N/A
Exceptions: N/A

Section 15 Regulatory Information

None listed.

Section 16 Additional Information

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MSDS No.: LL0129
Effective Date: October 31, 2005

SECTION I NAME

Product	Lead Nitrate, 0.05 Molar Solution
Chemical Synonyms	Lead Nitrate, Water Solution
Formula	Mixture.
Unit Size	up to 3.785 Lt.
C.A.S. No.	Mixture.

24 HOUR EMERGENCY ASSISTANCE

CHEMTREC
800-424-9300
Day 585-226-6177

NFPA

Health	2
Fire	0
Reactivity	0

HMIS *

HAZARD RATING

MINIMAL	SLIGHT	MODERATE	SERIOUS	SEVERE
0	1	2	3	4

SECTION II INGREDIENTS OF MIXTURES

Principal Component(s)	%	TLV Units
Lead nitrate: (CAS No. 10099-74-8)	1.66%	See Section V.
Water: (CAS No. 7732-18-5)	98.34%	None established.

WARNING! MAY BE HARMFUL IF SWALLOWED. MAY CAUSE SKIN AND EYE IRRITATION.

SECTION III PHYSICAL DATA

Melting Point (°F)	Freezes approx. 0°C (32°F)	Specific Gravity (H_2O = 1)	Approx. 1.0
Boiling Point (°F)	Approx. 100°C (212°F)	Percent Volatile by Volume (%)	98.34%
Vapor Pressure (mm Hg)	14 (water)	Evaporation Rate (Water =1)	Slightly less than 1.
Vapor Density (Air=1)	0.7 (water)		
Solubility in Water	Complete.		
Appearance & Odor	Clear, water white liquid; no odor.		

SECTION IV FIRE AND EXPLOSION HAZARD DATA

Flash Point (Method Used)	Non-flammable.	Flammable Limits in Air % by Volume	Lower	Upper
		N/A		
Extinguisher Media	Use any media suitable for extinguishing supporting fire.			

SPECIAL FIREFIGHTING PROCEDURES

If involved in fire situation, wear a NIOSH/MSHA-approved self-contained breathing apparatus. Use flooding amounts of water in early stages of fire.

UNUSUAL FIRE AND EXPLOSION HAZARDS

In fire conditions, water may evaporate from this solution, which may cause hazardous decomposition products to be produced as dust or fume.

D.O.T. NON-REGULATED.

Approved by U.S. Department of Labor "essentially similar" to form OSHA-20

SECTION V HEALTH HAZARD DATA LL0129

Threshold Limited Value
None established for Lead Nitrate. (ACGIH 2001). TWA for Lead [CAS No. 7439-92-1], inorganic dust and fumes, as Pb 0.05 mg/m^3.

Effects of Overexposure
Suspect cancer hazard. All lead compounds may cause cancer. Lead is a cumulative poison and exposure to even small amounts can raise the body's content to toxic levels. Nitrates entering the body by any route (ingestion, inhalation or absorption), can cause headache, vomiting, dizziness, cyanosis, decreased blood pressure and possible respiratory paralysis. Acute poisoning can lead to muscle weakness, "lead line" on the gums, metallic taste, definite loss of appetite, insomnia, dizziness, high lead levels in the blood and urine with shock, coma and death in extreme cases. Risk of cancer depends on level and duration of exposure. Target organs: Blood and central nervous system.

Emergency and First Aid Procedures
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. **EYES:** 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:** Remove contaminated clothing. Flush thoroughly with mild soap and water. If irritation occurs, get medical attention. **INHALATION:** Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.

SECTION VI REACTIVITY DATA

Stability			Conditions to Avoid
	Unstable		Excessive temperature to cause evaporation.
	Stable	X	

Incompatibility (Materials to Avoid) Ammonium thiocyanate, powdered carbon, lead hypophosphite.

Hazardous Decomposition Products Thermal decomposition or burning may produce toxic oxides of lead and nitrogen.

Hazardous Polymerization		Conditions to Avoid
May Occur	Will Not Occur	Not applicable.
	X	

SECTION VII SPILL OR LEAK PROCEDURES

Steps to be taken in case material is released or spilled
Absorb spill in an inert dry material, sweep up and place in a suitable container for proper disposal. Wash spill area with soap and water.

Waste Disposal Method
Discharge, treatment, or disposal may be subject to Federal, State or Local laws. These disposal guidelines are intended for the disposal of catalog-size quantities only.

Dispose of in an approved chemical landfill or contract with a licensed waste disposal agency.

SECTION VIII SPECIAL PROTECTION INFORMATION

Respiration Protection (Specify Type) None needed in normal laboratory handling. If misty conditions prevail, work in ventilation hood or wear a NIOSH/MSHA-approved respirator.

Ventilation				
	Local Exhaust	Not required.	Special	No.
	Mechanical (General)	Not required.	Other	No.

Protective Gloves	Rubber.	Eye Protection	Chemical safety goggles.

Other Protective Equipment Lab coat, apron, eye wash station, proper gloves.

SECTION IX SPECIAL PRECAUTIONS

Precautions to be Taken in Handling & Storing
Keep container tightly closed when not in use.
Store in a cool place. Wash thoroughly after handling.

Other Precautions
Read label on container before using. Do not wear contact lenses when working with chemicals. For laboratory use only. Not for drug, food or household use. Keep out of reach of children.

Do not take internally. Avoid contact with skin, eyes and clothing. Remove and wash contaminated clothing.

WARNING: THIS PRODUCT CONTAINS A CHEMICAL KNOWN TO THE STATE OF CALIFORNIA TO CAUSE CANCER.

Revision No.	Date	Approved	Chemical Safety Coordinator
3	10/31/05	James A. Bertsch	JAB

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