

# Diagnosing Diabetes

## Teacher Information

..... just add students™

### Summary

Students analyze simulated blood plasma samples collected during a glucose tolerance test for diabetes. They test glucose and insulin levels to determine if the patient has Type 1 or Type 2 diabetes.

### Core Concepts

- To maintain homeostasis the internal environment must be kept stable – within normal limits that are favorable for cell activities.
- Homeostasis in an organism is constantly threatened. Failure to respond effectively can result in disease or death.
- Organisms detect and respond to change in a variety of ways both at the cellular and at the organismal level.
- Blood sugar levels are maintained by insulin from the pancreas.
- Receptor molecules and hormones play an important role in the interactions between cells.
- If hormone signals are blocked, cell communication is disrupted and the organism's stability is affected.

### Time Required

Two 40-minute class periods + homework.  
Part 1 may be done as pre-lab homework.

### Kit contains

- 5 tubes of simulated “Blood Plasma” (0, 30, 60, 90 and 120 minutes)
- 1 tube of simulated “Insulin Indicator”
- 6 labeled droppers
- Simulated “Glucose Test Paper”
- Glucose/Insulin Test Color Charts
- Glucose Tolerance Testing Sheet
- Colored sheet of graphics for *What You Should Know About Diabetes and the Glucose Tolerance Test*

### Teacher Provides

- Safety goggles
- Paper towels for clean up
- Scissors
- Tape or glue

### 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.

## Reusing *Diagnosing Diabetes* kits

Teachers will need to instruct students on how to handle clean-up and return of the re-usable kit materials. For example, teachers might provide the following information for students:

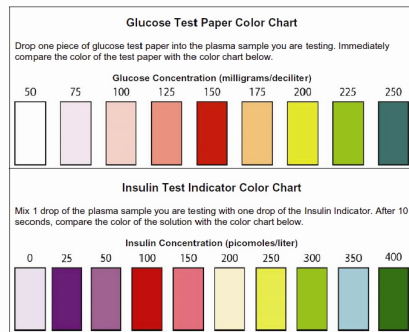
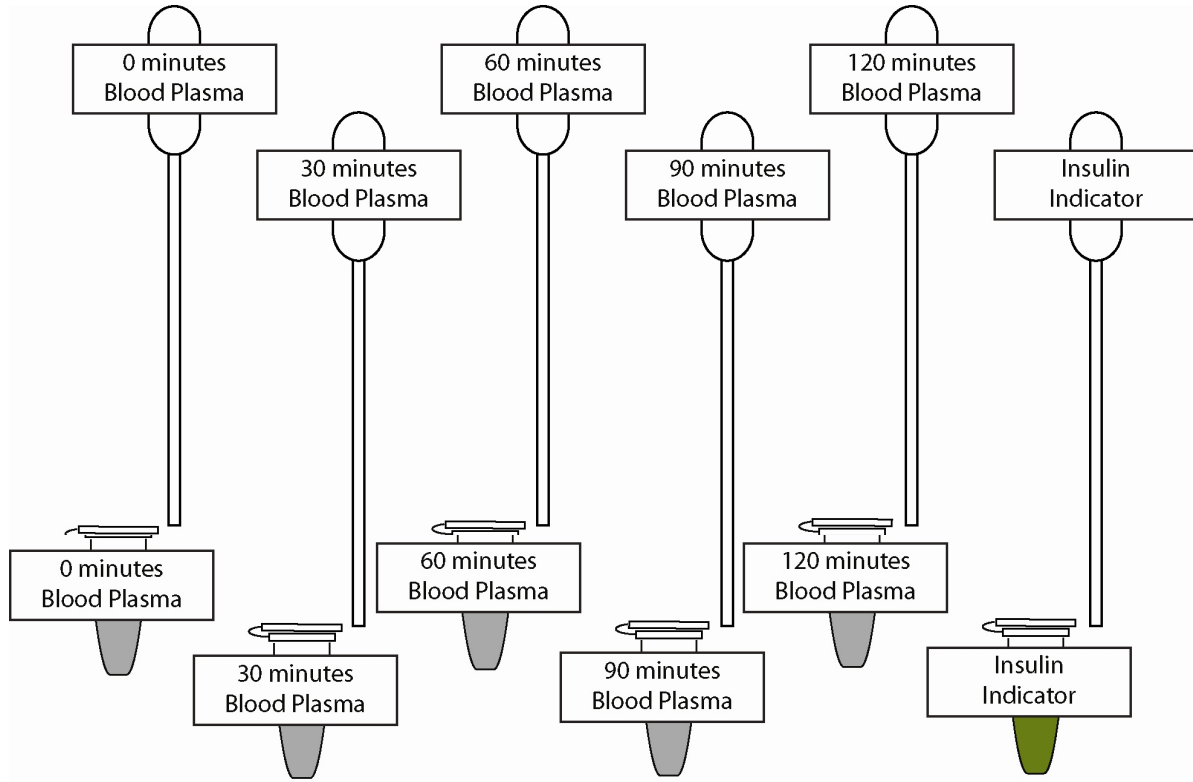
Discard	Rinse with water and dry with paper towel	Return to kit bag
<ul style="list-style-type: none"><li>Used glucose test papers</li></ul>	<ul style="list-style-type: none"><li>Glucose Tolerance Testing Sheet</li><li>All droppers</li></ul>	<ul style="list-style-type: none"><li>All labeled droppers (rinsed)</li><li>All labeled microtubes</li><li>Glucose Test Paper bag</li><li>Glucose/Insulin Color Chart*</li><li>Glucose Tolerance Testing Sheet (rinsed)</li></ul>

**\*Note:** Consider laminating printed parts of the kits (such as colored graphics or instruction cards) that will be reused.

Refills for *Diagnosing Diabetes* kits are available at [www.sciencetakeout.com](http://www.sciencetakeout.com). The **10 Kit Refill Pack** includes the following materials:

- Instructions and Quick Guide for refilling kit
- 6 graduated transfer pipets (for teacher use)
- 5 ml of each simulated “Blood Plasma” sample (0, 30, 60, 90, 120 minutes)
- 5 ml of “Insulin Indicator”
- 60 pieces of “Glucose Test Paper”
- 10 sheets of colored graphic cards. *Note: if each kit is being used by more than one student, you may make additional copies (in grayscale or color).*

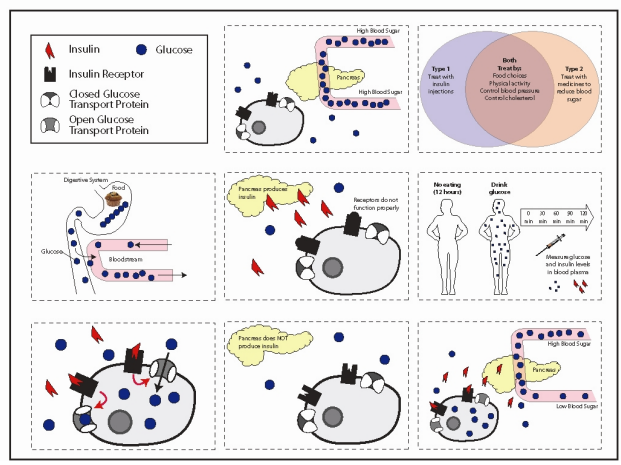
# Kit Contents Quick Guide



Glucose Test Paper

**Glucose Tolerance Testing Sheet**

Time of Blood Collection Minutes After Drinking Glucose Solution	Column 1 Drop of Blood Plasma for Glucose Test	Column 2 Drop of Blood Plasma for Insulin Test
0 (fasting)	<input type="text"/>	<input type="text"/>
30	<input type="text"/>	<input type="text"/>
60	<input type="text"/>	<input type="text"/>
90	<input type="text"/>	<input type="text"/>
120	<input type="text"/>	<input type="text"/>



## Read these instructions before using Science Take-Out kits

### Parental or Adult Supervision Required

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

### Safety Goggles and Gloves Strongly Recommended

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

### Warning: Choking and Chemical Hazard

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

### Chemicals Used in Science Take-Out Kits

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

### General Safety Precautions

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

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

# Diagnosing Diabetes:

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## The Case:

Your patient reports problems with fatigue and increased urination. You suspect that she might have diabetes. The results of her blood tests indicate that her blood glucose level is slightly above the normal range. You schedule the patient for a glucose tolerance test which is a medical test to check how the body metabolizes blood sugar.

## Your Tasks:

- Organize pictures to illustrate a patient information sheet
- Test and graph the glucose levels in blood plasma samples collected during the patient's glucose tolerance test.
- Test and graph the insulin levels in blood plasma samples collected during the patient's glucose tolerance test.
- Analyze the test results to determine if the patient has Type 1 or Type 2 diabetes.

## PART I:

### What you should know about diabetes and the glucose tolerance test

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You have a patient information sheet called *What You Should Know About Diabetes and the Glucose Tolerance Test*, that explains diabetes and the glucose tolerance test. However, many of your patients have difficulty reading this information sheet. You would like to add some pictures that you have collected to illustrate the information in the brochure.

1. Read the patient information sheet on the next three pages—*What You Should Know About Diabetes and the Glucose Tolerance Test*. For each paragraph, select the color graphic on the separate handout that illustrates the information. Cut and paste the graphics in the appropriate boxes on the information sheet.

## What You Should Know About Diabetes and the Glucose Tolerance Test

1. Key to the Diagrams

2. Most of the food you eat is turned into glucose, or sugar, for your body to use for energy. Your blood carries the glucose to all the cells in your body. Your blood always has some glucose in it because your body needs glucose for energy to keep you going. But too much glucose in the blood isn't good for your health. To maintain homeostasis, you need to keep a normal level of glucose in your blood.

3. Healthy people have a **feedback (control) mechanism** that maintains homeostasis by keeping blood glucose levels relatively constant and within a normal range. A high blood glucose level acts as a stimulus for the pancreas. The pancreas responds to this stimulus by secreting **insulin**, a chemical messenger (hormone). Insulin helps the glucose from food diffuse out of the blood and into your cells. This lowers blood sugar levels.

4. Most of the cells in the body carry **receptors** for the insulin hormone on their cell membranes. Once the insulin binds to one of these receptors, the receptor gives a signal to the cell's interior. This signal causes glucose transport proteins in the cell membrane to open and allow glucose to diffuse out of the blood and into body cells.

5. **Diabetes** means that your blood glucose (often called blood sugar) is too high because glucose can't get into your cells. When glucose can't get into your cells, it stays in your blood.

6. **Type 1 diabetes** accounts for 5% to 10% of all diagnosed cases of diabetes. Type 1 diabetes is called an autoimmune disease, because the immune system attacks the person's own pancreas cells. The cells in the pancreas that produce insulin are destroyed. Most people with Type 1 diabetes produce no insulin at all. Without insulin, glucose cannot get into the cells and accumulates in the blood.

7. **Type 2 diabetes** accounts for about 90% to 95% of all diagnosed cases of diabetes. People can develop Type 2 diabetes at any age - even during childhood, although most people with Type 2 diabetes are adults. People with Type 2 diabetes produce insulin but the insulin receptors on their cells do not respond properly to the insulin message. Being overweight and inactive increases the chances of developing type 2 diabetes.

8. Treatments for both types of diabetes include making wise food choices, being physically active, and controlling blood pressure and cholesterol levels. People with Type 1 diabetes must take insulin injections. People with Type 2 diabetes use oral medicines to lower blood glucose levels.

If diabetes is not properly treated, the high blood glucose levels can cause serious health complications including heart disease, blindness, kidney failure and leg amputation. Diabetes is the sixth leading cause of death in the United States.

9. A **Glucose Tolerance Test** is a diagnostic blood test for diabetes. After fasting (not eating) overnight, you are given a concentrated sugar solution (50 to 100 grams of glucose) to drink. Your blood is sampled periodically over the next several hours to test its glucose levels.

Normally, blood glucose does not rise very much and returns to normal within two to three hours. If you have diabetes, the blood glucose level is usually higher after fasting, rises more after drinking the glucose solution and takes from four to six hours to come down to normal levels.



Answer the following questions. Refer to the information and diagrams in *What You Should Know About Diabetes and the Glucose Tolerance Test*.

2. What is insulin? What does it do in your body?
3. What do the insulin receptor molecules on the cells in your body do?
4. List two similarities between Type 1 and Type 2 diabetes.
5. List two differences between Type 1 and Type 2 diabetes.
6. What health problems may result if a patient's diabetes is not properly treated to maintain normal blood glucose levels?

## **PART 2: Analyzing Blood Glucose Levels**

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To prepare for the glucose tolerance test, your patient fasted for 12 hours. To begin the test she drank a solution that contained a measured amount of glucose. Blood samples were collected immediately before she drank the glucose solution and every half hour after she drank the glucose solution. The blood sample was centrifuged to separate it into blood cells and blood plasma. You will test the concentration of glucose in the patient's blood plasma to determine if she has diabetes.

1. Your lab kit has 5 samples of the patient's blood plasma that were collected at various time intervals during the patient's glucose tolerance test.

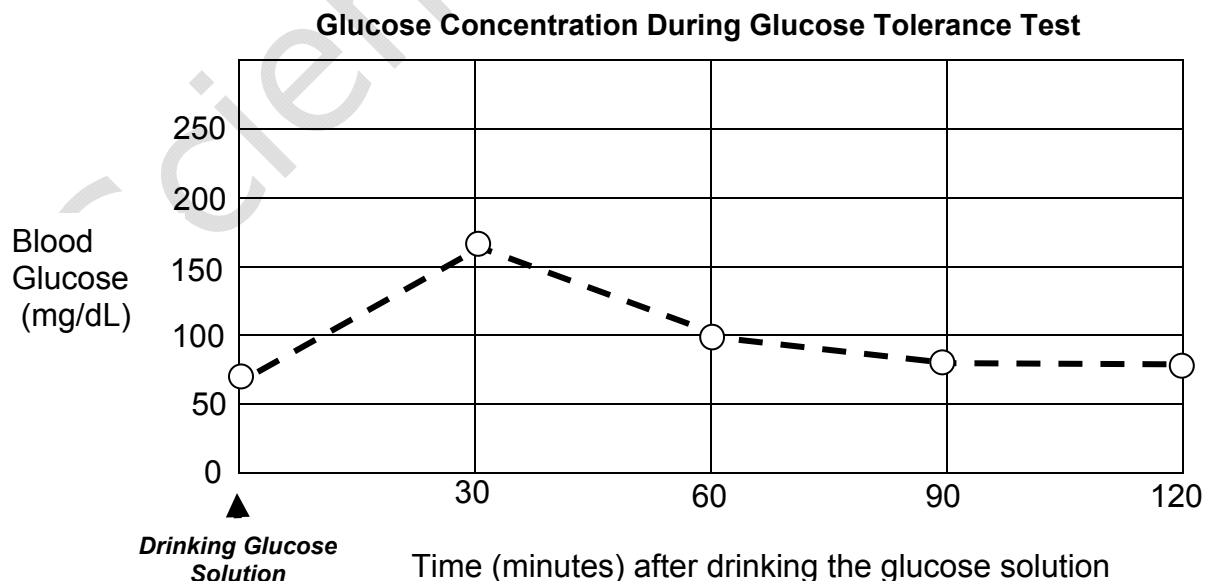
- Use Column 1 on the "Glucose Tolerance Testing Sheet." Place 1 drop of the appropriate plasma samples to be tested in the appropriate circles in Column 1. Save the samples of patient blood plasma for use in Part 3.
- Place a strip of glucose test paper into each of the circles in Column 1 of the "Glucose Tolerance Testing Sheet" that contain the plasma samples that you are testing. Immediately compare the color of the test paper with the color on the Glucose Test Paper Color Chart. Record the results of the glucose tests in Table 1 below.

**TABLE 1**

Time of Blood Collection Minutes After Drinking Glucose Solution	Glucose Level in Blood (milligrams/deciliter)
<b>0 (after fasting)</b>	
<b>30</b>	
<b>60</b>	
<b>90</b>	
<b>120</b>	

- The graph below shows the blood plasma glucose levels for a healthy person who does not have diabetes. Plot the data from the patient's glucose test results (from Table 1) on the graph.

Key:   
 - - - - = Healthy person who does not have diabetes   
 \_\_\_\_\_ = The patient



Use the information in the *What You Should Know About Diabetes and the Glucose Tolerance Test* fact sheet to help you interpret the results of the patient's glucose tolerance test.

5. Explain why the blood glucose level for the healthy person was low (70 mg/dL) at the beginning of the glucose tolerance test.
6. Explain why the blood glucose level for the healthy person rises after drinking the glucose solution.
7. Explain what causes the healthy person's blood glucose levels to decrease after 30 minutes.
8. Explain what might cause the patient's blood glucose levels to remain high after 30 minutes.
9. Based on the information in this graph, do you think the patient has diabetes? Support your answer with evidence from the graph.
10. Do you have enough information to determine if the patient has Type 1 or Type 2 diabetes? If not, how would you figure this out?

## PART 3: Analyzing Blood Insulin Levels

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There are two types of diabetes that result in higher than normal blood glucose levels – called Type 1 and Type 2 diabetes. A person with Type 1 diabetes does not produce insulin. A person with Type 2 diabetes does produce insulin but their cells are unable to respond to the insulin message.

To determine whether the patient has Type 1 or Type 2 diabetes, you need to test the concentration of insulin in the patient’s blood plasma.

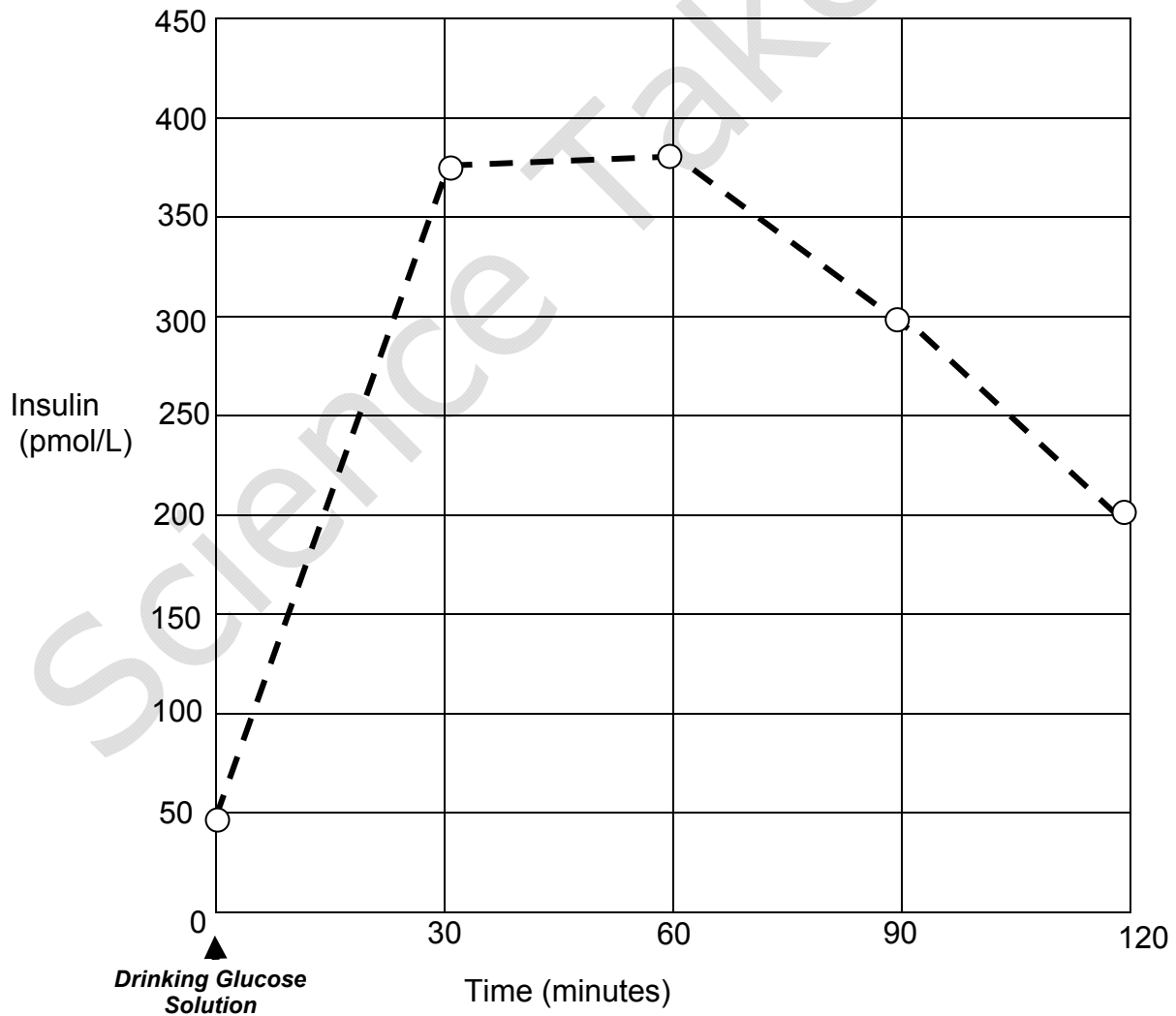
1. Use Column 2 on the “Glucose Tolerance Testing Sheet.” Place 1 drop of the appropriate plasma samples to be tested in the appropriate circles in Column 2.
2. Add 1 drop of the Insulin Indicator to the plasma in each of the circles in Column 2. After 10 seconds, compare the color of the fluid in each circle with the Insulin Test Indicator Color Chart.
3. Record the results of the insulin tests in Table 2 on the next page.
4. The graph on the next page shows the blood plasma insulin levels for healthy person who does not have diabetes. Plot the data from the patient’s insulin test results on the graph.

TABLE 2

Time for Blood Collection Minutes After Drinking Glucose Solution	Insulin Level in Blood (picomole/liter)
0 (after fasting)	
30	
60	
90	
120	

Key:   
 - - - - = Healthy person who does not have diabetes  
 ————— = The patient

Insulin Concentration During Glucose Tolerance Test



Use the information in the *What You Should Know About Diabetes and the Glucose Tolerance Test* fact sheet to help you interpret the results of the patient's glucose tolerance test.

5. Compare the insulin levels in a healthy person with the insulin levels in the patient.
  
6. Based on the information in the graph, do you think the patient has **Type 1** or **Type 2** diabetes? Support your answer with information from the graph.
  
7. Why would insulin injections typically not be used to treat the patient's diabetes?
  
8. What treatment plan would you suggest to keep the patient's glucose levels within normal range?
  
9. What health problems may result if the patient does not follow the treatment plan suggested to keep her blood glucose levels within normal range?

# MATERIAL SAFETY DATA SHEET

## 1. PRODUCT AND COMPANY IDENTIFICATION

Product Name (as printed on the label): "Insulin Indicator Solution"

Product identity: 0.05% methyl red, 0.05% bromothymol blue solution

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

Telephone number for information: (866)260-0501 Medical emergency phone number (Chemtrec): (800) 424-9300

Date of this MSDS: 7/6/09

## 2. COMPOSITION/INFORMATION ON INGREDIENTS

Ingredients	CAS Numbers	% Weight/Volume	TLV Units
Methyl red	63451-28-5	0.05%	None established
Bromothymol blue sodium salt	34722-90-2	0.05%	None established
Water	7732-18-5	99.9%	None established

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

### EMERGENCY OVERVIEW

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

Potential Health Effects EYES: May cause irritation. SKIN: May cause slight irritation. INHALATION: n/a  
INGESTION: May cause gastrointestinal discomfort

## 4. FIRST AID MEASURES

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

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

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

## 5. FIRE FIGHTING MEASURES

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

Extinguisher Media: Any means suitable for extinguishing surrounding fire

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

Unusual Fire and Explosion Hazards: None

## 6. SPILL OR LEAK PROCEDURES

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

## 7. HANDLING AND STORAGE

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

## 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Respiratory Protection: None required

Ventilation: Local Exhaust: Preferred

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

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

Other Protective Clothing or Equipment: Lab coat, apron, eye wash, safety shower.

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## 9. PHYSICAL AND CHEMICAL PROPERTIES

Melting Point: <2°C

Vapor Pressure: Ca 50 @ 20°C

Specific Gravity (H<sub>2</sub>O=1): ~1

Evaporation Rate: ~ same as water

Appearance and Odor: Green liquid

Boiling Point: >98°C

Vapor Density: ~ same as water

Percent Volatile by Volume: information not available

Solubility in Water: soluble

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## 10. STABILITY AND REACTIVITY

Stability: Stable

Materials to Avoid: none known

Hazardous Decomposition Products: none

Reactive under what conditions: none known

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## 11. TOXICOLOGICAL INFORMATION

Toxicity (rat) LD <sub>50</sub>
Acute oral toxicity = information not available
Acute toxicity from vapor = information not available

Effects of Overexposure:

Acute: Irritation of eyes/skin

Chronic: Irritation of eyes/skin

Target Organs: Eyes, skin.

Primary Route(s) of Entry: Ingestion

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## 12. ECOLOGICAL INFORMATION

No data available

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## 13. DISPOSAL CONSIDERATIONS

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

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

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## 14. TRANSPORTATION INFORMATION

No data available

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## 15. REGULATORY INFORMATION

No data available

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## 16. ADDITIONAL INFORMATION

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



# MATERIAL SAFETY DATA SHEET

## 1. PRODUCT AND COMPANY IDENTIFICATION

Label on Dropper	Contents of Dropper
<i>Plasma 0 min</i>	Buffer pH 3
<i>Plasma 30 min</i>	Buffer pH 7
<i>Plasma 60 min</i>	Buffer pH 9
<i>Plasma 90 min</i>	Buffer pH 9
<i>Plasma 120 min</i>	Buffer pH 7

Distributor: Microessential Laboratory Inc. PO Box 10824, 4224 Avenue H, Brooklyn, NY 11210

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

Date of this MSDS: 12/31/08

## 2. COMPOSITION/INFORMATION ON INGREDIENTS

Product	Ingredients	CAS Numbers	% Weight/Volume (balance is water)
pH 3 buffer	Sulphamic acid	5329-14-16	0.10%
	Potassium biphthalate	877-24-7	0.35%
pH 7 buffer	Potassium phosphate monobasic	7778-77-0	0.15%
	Sodium phosphate dibasic	7558-79-4	0.30%
pH 9 buffer	Sodium carbonate	497-19-8	0.10%
	Sodium bicarbonate	144-55-8	0.35%

For all the ingredients OSHA PEL: TWA – none estab. STEL – none estab.  
ACGIH TLV: TWA – none estab. STEL – none estab.  
NIOSH REL: TWA – none estab. STEL – none estab.  
NIOSH ILDH: none estab.

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

### EMERGENCY OVERVIEW

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

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

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

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

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

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

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

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

Extinguisher Media: Any means suitable for extinguishing surrounding fire

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

Unusual Fire and Explosion Hazards: No data available

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

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

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

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

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

Respiratory Protection: n/a  
Ventilation: Local Exhaust: Preferred  
Mechanical(General): Acceptable  
Special: No  
Other: No

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

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

Melting Point: ~0°C Boiling Point: ~100°C  
Vapor Pressure: information not available Vapor Density: information not available  
Specific Gravity (H<sub>2</sub>O=1): ~1 Percent Volatile by Volume: >99  
Evaporation Rate: information not available Solubility in Water: soluble  
Appearance and Odor: Clear colorless liquid

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

Stability: Stable Materials to Avoid: strong acids and bases  
Hazardous Decomposition Products: none known Hazardous Polymerization: will not occur

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**11. TOXICOLOGICAL INFORMATION**

Ingredient	Toxicity (oral-rat) LD <sub>50</sub>
Sulphamic acid	3160 mg/kg
Potassium biphthalate	3200 mg/kg
Sodium phosphate dibasic	17 g/kg
Potassium phosphate monobasic	7100 mg/kg
Sodium carbonate	4090 mg/kg
Sodium bicarbonate	4220 mg.kg

Effects of Overexposure (for all pH buffers):  
Acute: Essentially non-hazardous. Possible irritation of eyes/skin/stomach  
Chronic: None known.  
Conditions aggravated/Target organs: none known  
Target Organs: Eyes, skin, and gastrointestinal tract.  
Primary Route(s) of Entry: Ingestion or skin contact.

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**12. ECOLOGICAL INFORMATION – for all pH buffer products** No ecological data available

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

Waste Disposal Methods: Dispose in accordance with all applicable Federal, State and Local regulations.  
Always contact a permitted waste disposer (TSD) to assure compliance.

**14. TRANSPORTATION INFORMATION** D.O.T. SHIPPING NAME: Not regulated

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

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

OSHA regulations: Air Contaminant (29 CFR 1910.1000) – not listed

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**16. ADDITIONAL INFORMATION**

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