STO-123

Yeast Populations

Teacher Information

science take-out
just add students™

Summary

Students test samples from a yeast population to determine yeast population size, the pH of the environment, and the amount of sugar present. They graph their results and compare them with results from another researcher.

Core Concepts

The growth and survival of organisms depend on the environmental conditions including food supply and pH.

Time Required

Two 40-minute class periods

Suggestion

The graph sheet for this lab activity is on the last page. To make it easier for students, you may tell them to tear this page off for use during the lab activity.

Kit contains

- 3 tubes of Yeast Population A samples (Day 2, Day 4, Day 6)
- Tube of Sugar Indicator
- Bag containing 3 strips of pH Indicator Paper
- Droppers labeled:
  - Sugar Indicator Solution
  - Yeast Population A Day 2
  - Yeast Population A Day 4
  - Yeast Population A Day 6
- Sugar Test Strip
- pH and Sugar Color Chart

Teacher Provides

- Safety goggles
- Calculator (optional)

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 *Yeast Populations* kits

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

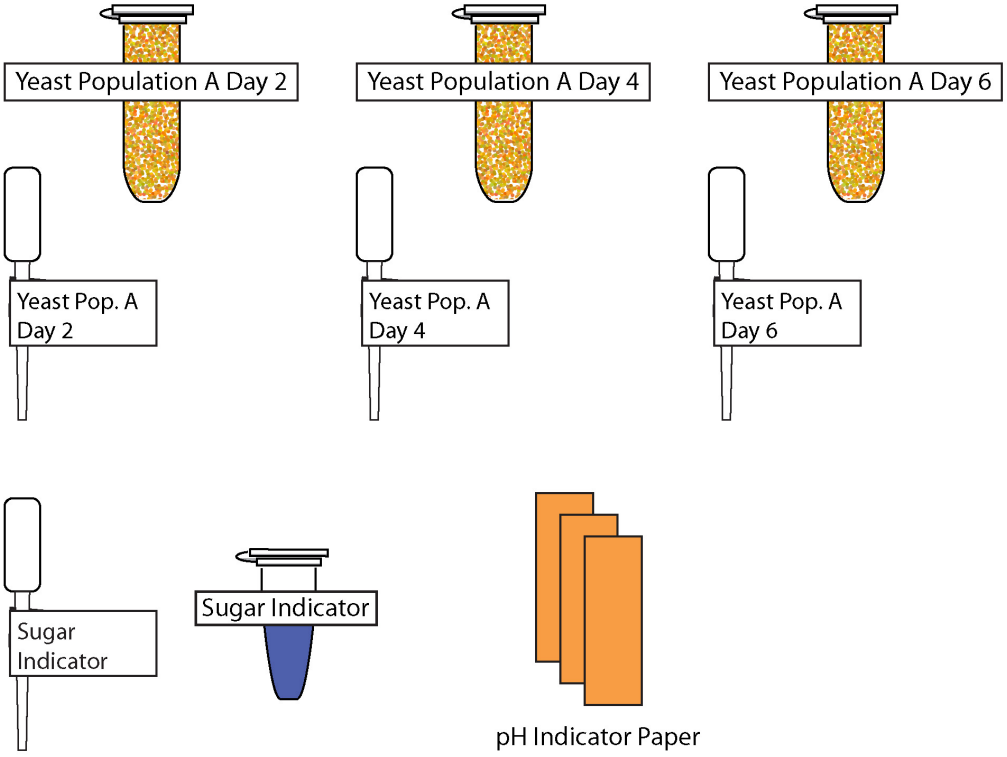
Discard	Rinse with water and dry with paper towel	Refill and Return to kit
• Used pH indicator paper	• All droppers	• All labeled microtubes • All labeled droppers (rinsed) • pH and Sugar Color Charts • Sugar Test Strips

Note: Consider laminating printed parts of the kits (such as the pH and Sugar Color Charts) that will be reused.

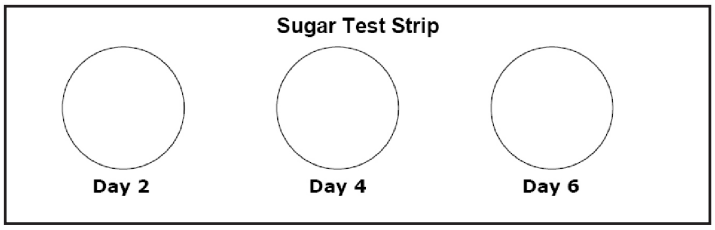
Refills for the *Yeast Populations* kits are available at www.sciencetakeout.com. The 10 Kit Refill Pack includes the following materials:

- 30 strips of pH indicator paper
- 15 ml of Sugar Indicator
- 40 ml of each of the following Yeast samples:
    - Yeast Population A Day 2
    - Yeast Population A Day 4
    - Yeast Population A Day 6
- Bag of fine sand ("Yeast")
- Small scoop for transferring sand to microtubes
- 4 graduated transfer pipets

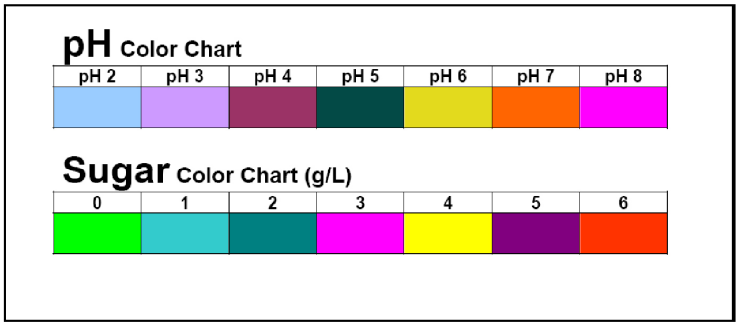
Kit Contents Quick Guide



pH Indicator Paper



Sugar Test Strip



pH and Sugar Color Chart

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.

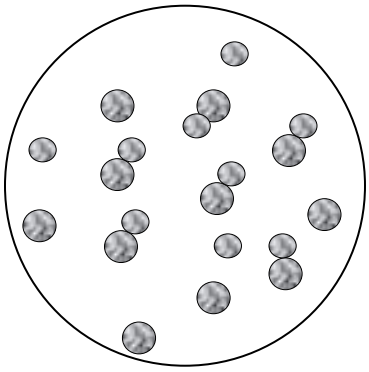
Yeast Populations: *Teacher Answer Key*

Introduction

A **population** is a group of individuals of the same species that live in the same place at the same time. The size of a population can change over a period of time. Increases or decreases in the size of a population may result from environmental conditions such as disease, predators, food supply, temperature, availability of space, migration, and pollution.

Biologists often use one-celled, microscopic organisms such as yeast to study the effect of environmental conditions on changes in populations. Biologists study yeast populations because yeast reproduce rapidly and can be grown in sealed test tubes, with sugar as their food supply. In this lab activity you will simulate experiments that biologists do with real yeast cells.

Yeast Cells Viewed at 1000X Magnification



Yeast Population A was grown in a solution of water and sugar in a large container for 8 days. Small samples were drawn from the Yeast Population A on Days 0, 2, 4, 6, 8, and 10.

Tests on samples of the Yeast Population A for Days 0, 8 and 10 have already been performed.

You will perform tests on the Yeast Population A samples that were taken on Days 2, 4, and 6 to determine changes in the:

- pH of the environment due to carbon dioxide production
- Amount of sugar remaining
- Population size

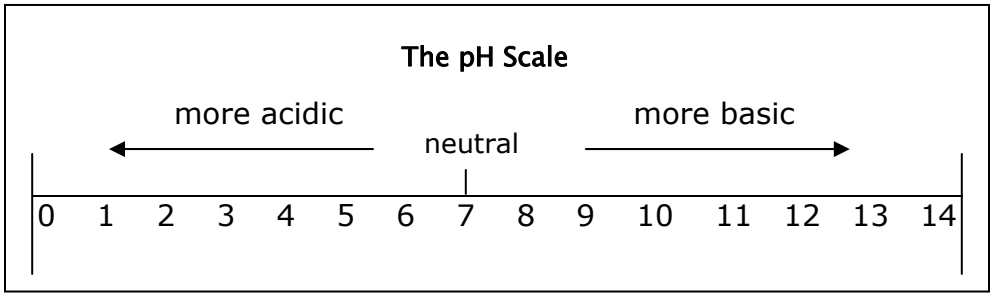
Test 1: pH of the environment due to carbon dioxide production

Yeast produce carbon dioxide as one of the wastes of anaerobic respiration (fermentation). Carbon dioxide dissolves in water to form carbonic acid. The carbonic acid will make the yeast environment more acidic.

Anaerobic Cellular Respiration (Fermentation) in Yeast

Glucose (sugar) → Alcohol + Carbon dioxide + Energy for life activities

You will determine the pH of the Day 2, 4 and 6 Yeast Population A samples. **pH** is a measure of the acidic or basic nature of a solution. The more acidic the solution is, the lower the pH number will be on the pH scale.



1. The yeast may have settled to the bottom of the tubes. Shake the three tubes of Yeast Population A (Day 2, 4, and 6) to mix the yeast with the liquid in the tube.

2. Determine the pH of each sample by quickly dipping one end of a pH indicator paper strip into each of the Yeast Population A samples for Days 2, 4, and 6. Use a new indicator paper strip for each sample.

3. Compare the color of the pH indicator paper to the pH color chart. Complete Table 1 by recording the pH number in the appropriate box.

Table 1: pH of Yeast Population A

Day	0	2	4	6	8	10
pH	7	***7***	***6***	***5***	5	5

4. Plot all of the data in Table 1 on the grid in Graph 1 (on the last page of this lab). Connect the points with a dashed line (– – –) as shown in the key.

5. Describe how the pH changes over the 10 day period.

   Students may provide more specific information but at least should indicate that the pH decreases and then stays the same.

6. What substance produced during yeast respiration (fermentation) causes the change in pH?

   Carbon dioxide or carbonic acid

Test 2: Sugar analysis

Yeast use sugar as a source of energy for their anaerobic respiration (fermentation). You will determine the amount of sugar present in the Yeast Population A samples for Days 2, 4, and 6.

1. To determine the amount of sugar present in each of the samples on the test strip.

   - Use the plastic Sugar Test Strip.
   - Use the dropper labeled "Sugar Indicator" to place 1 drop of Sugar Indicator on each of the circles on the Sugar Test strip.
   - Use the matching droppers to place 2 drops of the Yeast Population A samples for Days 2, 4, and 6 in the appropriate circles on the Sugar Test Strip.
   - Compare the color of the sugar test strip to the Sugar Color Chart. Complete Table 2 by recording the grams/L number in the appropriate box.

Table 2: Amount of Sugar for Yeast Population A (grams/liter)

Day	0	2	4	6	8	10
Sugar (grams/L)	5	***4***	***2***	***1***	1	1

2. Plot the data on the grid in Graph 1 (on the last page of this lab). Connect the points with a dotted line (● ● ● ● ●) as shown in the key.

3. Describe how the concentration of sugar changes over the 10 day period.

   Students may provide more specific information but at least should indicate that the concentration of sugar decreases and then stays the same.

Test 3: Population size

Yeast are microscopic one-celled organisms. The illustrations on the right show samples of yeast populations viewed through a microscope. You will use these illustrations to determine the yeast population size in the Yeast Population A samples for Days 2, 4, and 6

1. Instead of counting all of the yeast cells in the illustrations, you only count the number of yeast cells that are in each of the **four boxes** on the counting grids.

2. Count and record the number of yeast cells in each of the **four boxes** of the counting grid for Day 2. Then calculate and record the average on Table 3.

   ___***2***__ ___***3***_ __***3***_ ___***2***__

   Average __***2.5***____

3. Count and record the number of yeast cells in each of the **four boxes** of the counting grid for Day 4. Then calculate and record the average on Table 3.

   ___***8***_ ___***7***_ __***8***__ ___***9***__

   Average __***8***_____

4. Count and record the number of yeast cells in each of the **four boxes** of the counting grid for Day 6. Then calculate and record the average on Table 3.

   ___***11***__ ___***9***__ ___***10***__ __***10***__

   Average ____***10***_

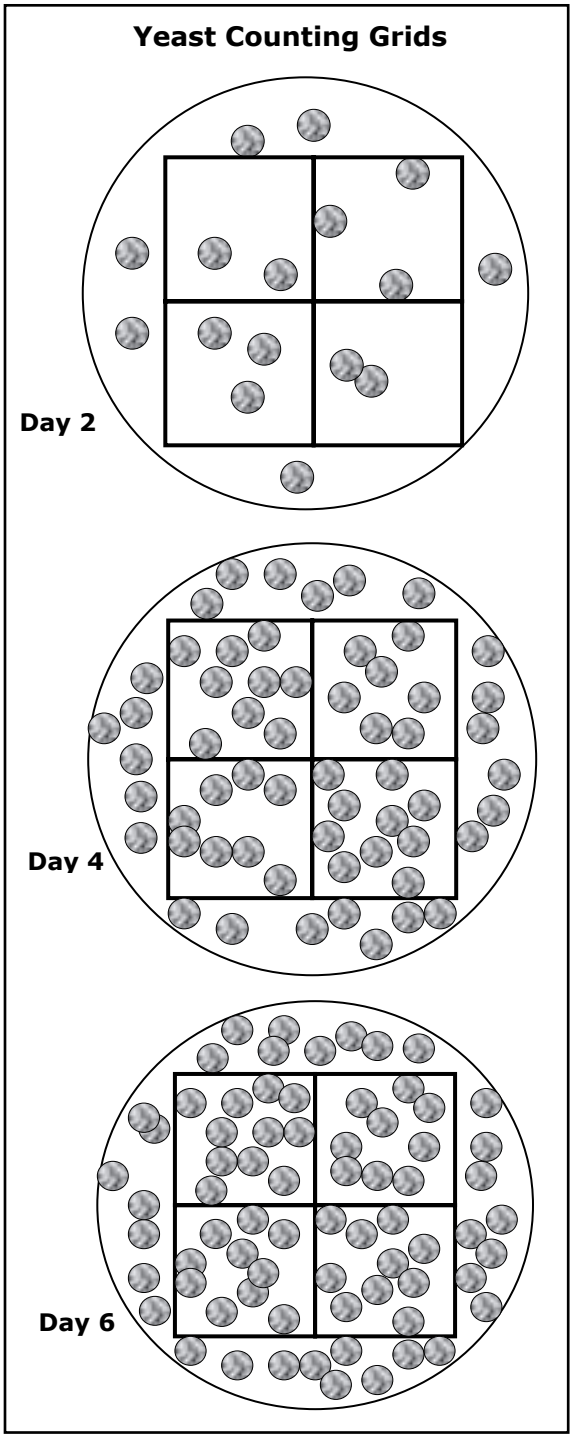


Table 3: Population Size for Yeast Population A
(Average number of "yeast cells" in the boxes on the counting grid)

Day	0	2	4	6	8	10
Population Size (Average)	0.5	***2.5***	***8***	***10***	0	0

5. Plot the population size data on the grid in Graph 1 (on the last page of this lab). Connect the points with a solid line (————) as shown in the key.

7. Describe how size of the yeast population changes over the 10 day period.

Students may provide more specific information but at least should indicate that the population increases and then decreases.

Comparing Two Yeast Populations

Another biology researcher conducted a similar experiment to study the growth of Yeast Population B. The data from his research is shown in Graph 2 (on the last page of this lab).

Base your answers to the questions below on the information in Graph 1 and Graph 2.

- Graph 1 shows the changes in Yeast Population A that you investigated.
- Graph 2 shows the changes in Yeast Population B studied by another researcher.

1. Which type of line (dashed, dotted, or solid on both of the graphs) represents the changes in yeast population size in both of the experiments? ***A solid line***

2. The pH decreased in Graphs 1 and 2. Explain what caused the pH to decrease. *Hint: Refer back to the information in Test 1.*

Yeast produce carbon dioxide as one of the wastes of respiration (fermentation). Carbon dioxide dissolves in water to form carbonic acid. The more acidic the solution is, the lower the pH will be.

3. Compare the amount of sugar present on Day 0 for Yeast Populations A and B.

Yeast Population A had more sugar present than Yeast Population B.

4. The amount of sugar decreased in both Graph 1 and Graph 2. Explain what caused this decrease in the amount of sugar.

Yeast use sugar as a source of energy for their respiration.

5. Describe one similarity between the growth of Yeast Population A and Yeast Population B.

   They both increased and then decreased. OR They both started at 0.5.

6. Describe one difference between the growth of Yeast Population A and Yeast Population B.

   Population B grew more rapidly than population A. Population A reached a maximum population size in 6 days. Population B reached a maximum population size in 4 days.

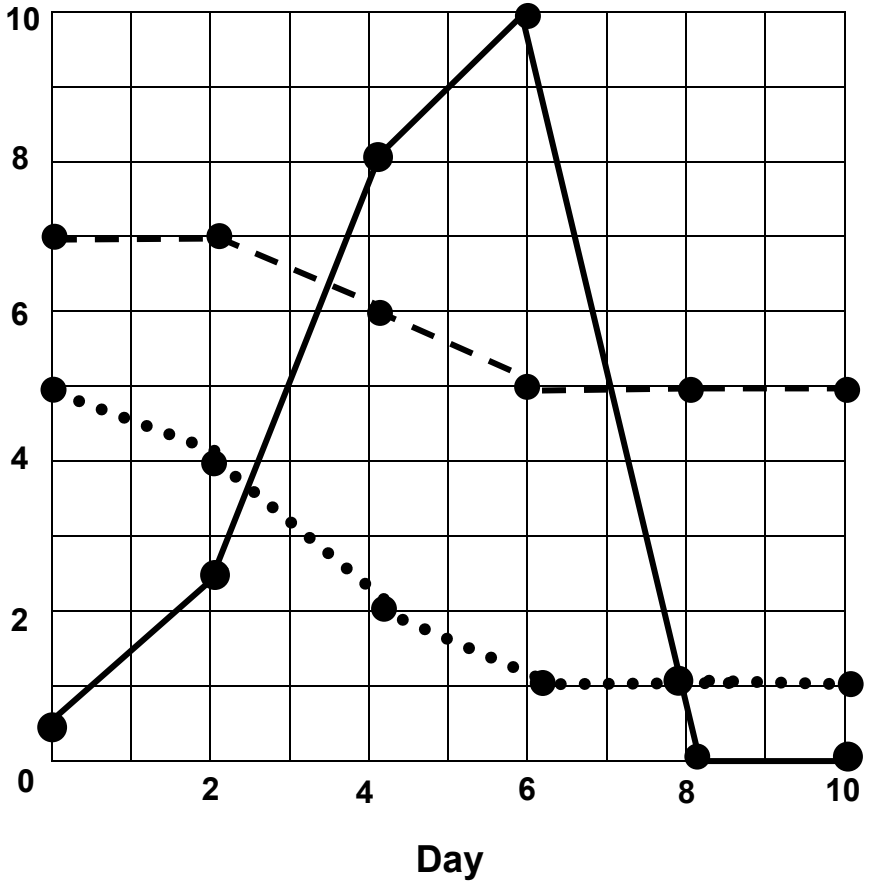
7. Based on the information in the graphs, which pH level appears to be toxic (poisonous) to yeast cells?

   pH 5

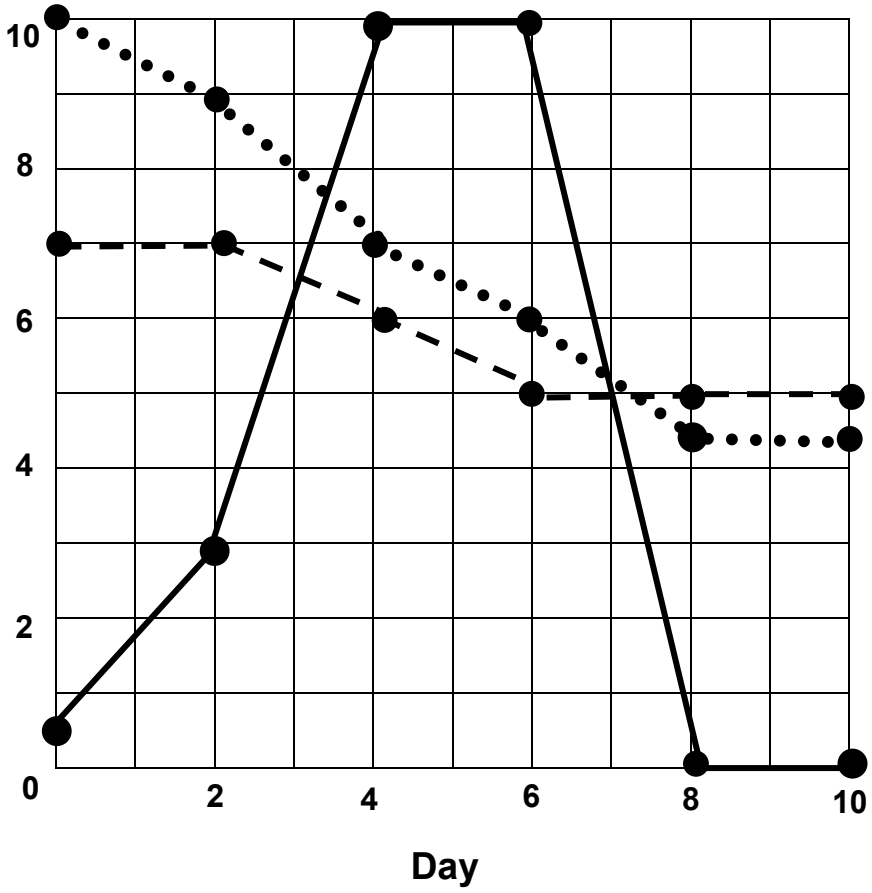
8. What evidence do you have from the two graphs that a lack of sugar is NOT the cause for the death of the yeast populations?

   There was still sugar present when the yeast population decreased.

Graph 1: Changes in Yeast Population A



Graph 2: Changes in Yeast Population B



Key

pH – – –

Sugar (g/L) • • • • •

Population Size ——

MATERIAL SAFETY DATA SHEET

1. PRODUCT AND COMPANY IDENTIFICATION

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

Product identity: 0.04% bromothymol blue solution

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

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

Date of this MSDS: 7/12/10

2. COMPOSITION/INFORMATION ON INGREDIENTS

Ingredients	CAS Numbers	% Weight/Volume	TLV Units
Bromothymol blue sodium salt	34722-90-2	0.04%	None established
Water	7732-18-5	99.96%	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.

9. PHYSICAL AND CHEMICAL PROPERTIES

Melting Point: <2°C
Boiling Point: >98°C
Vapor Pressure: Ca 50 @ 20°C
Vapor Density: ~ same as water
Specific Gravity (H_2O=1): ~1
% Volatile by Volume: info. not avail.
Evaporation Rate: ~ same as water
Solubility in Water: soluble
Appearance and Odor: Green liquid

10. STABILITY AND REACTIVITY

Stability: Stable Materials to Avoid: none known
Hazardous Decomposition Products: none
Reactive under what conditions: none known

11. TOXICOLOGICAL INFORMATION

Toxicity (rat) LD_{50}
Acute oral toxicity = information not available
Acute toxicity from vapor = information not available

Effects of Overexposure:
Acute: Irritation of eyes/skin
Chronic: Irritation of eyes/skin
Target Organs: Eyes, skin.
Primary Route(s) of Entry: Ingestion

12. ECOLOGICAL INFORMATION No data available

13. DISPOSAL CONSIDERATIONS

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

14. TRANSPORTATION INFORMATION No data available

15. REGULATORY INFORMATION No data available

16. ADDITIONAL INFORMATION

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

MATERIAL SAFETY DATA SHEET

1. PRODUCT AND COMPANY IDENTIFICATION

Product Name (as printed on the label) and identity:

Label on Tube	Contents
Yeast Population A Day 2	Buffer pH 3 + sand
Yeast Population A Day 4	Buffer pH 7 + sand
Yeast Population A Day 6	Buffer pH 10 + sand

Distributor: Science Take-Out, LLC. PO Box 205, Pittsford, NY 14534
Telephone number for information: (585)764-5400
Medical emergency phone number (Chemtrec): (800) 424-9300

Date of this MSDS: 7/12/10

2. COMPOSITION/INFORMATION ON INGREDIENTS

Product	Ingredients	CAS Numbers	% Weight/Volume (balance is water)
pH 3 buffer	Sulphamic acid Potassium biphthalate	5329-14-16 877-24-7	0.10% 0.35%
pH 7 buffer	Potassium phosphate monobasic Sodium phosphate dibasic	7778-77-0 7558-79-4	0.15% 0.30%
pH 9 buffer	Sodium carbonate Sodium bicarbonate	497-19-8 144-55-8	0.25% 0.15%

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

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

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

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

7. HANDLING AND STORAGE – for all pH buffer products

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

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

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

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

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

Melting Point: ~0°C — Boiling Point: ~100°C
Vapor Pressure: info. not avail. — Vapor Density: info. not available
Specific Gravity (H_2O=1): ~1 — Percent Volatile by Volume: >99
Evaporation Rate: info. not avail. — Solubility in Water: soluble
Appearance and Odor: Clear colorless liquid

10. STABILITY AND REACTIVITY – for all pH buffer products

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

11. TOXICOLOGICAL INFORMATION

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

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

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

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

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

16. ADDITIONAL INFORMATION

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