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An Introduction to Milk: The Mystery, the History, and the Microbes

By Sarah Yearby, ABE San Francisco Bay

ABE Master Teacher Fellowship Program

AMGEN Biotech Experience

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We are grateful to the ABE Master Teacher Fellows for sharing their work with the ABE community. If you have questions about any of the project components, please reach out to us at ABEInfo@edc.org, and we will be happy to connect you with the author and provide any assistance needed.

AMGEN Biotech Experience

Scientific Discovery for the Classroom

San Francisco Bay Area

Exploring CRISPR-Cas9 in the High School Classroom Using Literature, Modeling, Lab Investigations, Projects, and Ethical Analysis

by Sarah Yearby, 2024–25 ABE Master Teacher Fellow, ABE San Francisco Bay Area

My overall topic is… (1–3 sentences)	This project was designed as a series of seven lab activities that can be used as a complete unit or as individual activities and was originally inspired by another ABE Master Teacher Fellowship project completed by Declan Cathcart (ABE Ireland). The entire series focuses on a widely available substance, milk! Students will be asked to investigate the history of milk as a food, determine its chemical composition using spectrophotometry, and grow and stain probiotic cultures
I want students/ participants to understand _____and be able to_____.	• Understand the history of human ability to digest milk and the variations in that ability • Analyze an infographic to determine the reported chemical composition of milk • Perform chemical analysis of several biomolecules in milk • Identify what bacterial cultures should be found in milk-based probiotics • Identify the difference between Gram-positive and Gram-negative bacteria
The reason why I wanted to pursue this is…	I wanted to add to the labs that I have always seen in exploring milk, but I wanted to add more higher end assays to increase depth of knowledge and mastery of lab skills for my students.
Resources used or created	See list of materials in each activity.
Skills or Standards addressed	• To identify the biomolecules that are present in milk using Bradford and Benedict's Assays including analysis by spectrophotometry • To use computer technology to create a standard curve graph in order to calculate the concentration of a protein sample • To perform serial dilutions of fermented dairy products in order to analyze the resulting bacterial growth on MRS agar plates • To prepare and bacterial cultures using aseptic technique • To prepare, visualize and analyze several milk-based probiotic cultures using Gram staining

	• To analyze Gram-stained bacterial cultures under oil immersion microscopy
Assessments or Post-Surveys	• Formal lab analysis using “ReePePa” method • ReePePa = Results, Evidence,Possible Error, Practical Application • Explanation of data • Possible error analysis • Practical application discussion • Lab skill assessment of bacterial plating and serial dilution of probiotic cultures • Lab skill assessment of Gram staining of probiotic cultures
LabXChange Resources	Class Code: 6A4F59 Class Name: Milk: the Mystery, History and Microbes

Activity: An Introduction to Milk: The Mystery, the History, and the Microbes

Overview: The students will be shown a video on the history of milk and read the introduction to give them insight into all the interesting qualities of milk

LEARNING GOALS	ASSESSED OUTCOME	FOCUSED SKILLS
• To practice the skill of annotation • To identify the many uses of milk • To understand why we are using milk as a lab reagent	Students will familiarize themselves with the history of milk as a food product	• Annotation • Reading scientific texts

SEQUENCE

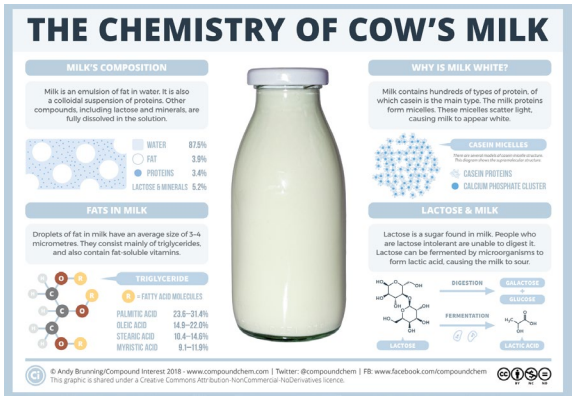
ACTIVITY	MATERIAL AND DETAIL	TEACHER	STUDENTS	TIME
Video	The Science of Milk - Jonathan J. O'Sullivan	Project video (5:24); turn on captions for equal access for all learners	Take notes	5–10 min
Reading	Annotations instructions with Teacher and Student Version	Provide students with a copy of the annotation activity and a copy of the article, or make available online	Read and annotate article	10–20 min
Think-Pair-Share	Students should use their annotations and video notes to help answer the questions: • What are three new things you learned about milk? • What is one thing you still want to know?	Model productive discussion for the students; perhaps pairing up with another student to give an example	Work with table partner to answer the questions	15–20 min
Possible Extension	Have student use the internet to look up types of milk other than cow's milk and their history.			

Investigation 1: Inquiry into the Biochemistry of Milk

Overview: Students will be shown an infographic on the chemistry of cow's milk and be asked several inquiry questions.

LEARNING GOALS	ASSESSED OUTCOME	FOCUSED SKILLS
• To practice reading infographics • To identify the many biochemicals in milk • To understand why we are using milk as a lab reagent	Students will familiarize themselves with the biochemistry of milk.	• Reading infographics • Assessing prior knowledge • Practicing Claim, Evidence and Reasoning protocols

SEQUENCE

ACTIVITY	MATERIAL AND DETAIL	TEACHER	STUDENTS	TIME
Observing the Infographic	https://www.compoundchem.com/wp-content/uploads/2018/06/The-chemistry-of-milk-v2.pdf 	Provide students with a copy of the infographic or make it available online; Teacher can also laminate or place copies in sheet protectors for future use.	Have students look over the infographic.	5 min
Inquiry Worksheet		Provide students with a copy of the inquiry worksheet or make available online.	Read the questions and use the provided infographic.	25–35 min
Think-Pair-Share	Students should use their infographic and inquiry worksheets to compare their answers and give each other warm (positive) and cool (areas for growth) feedback.	Model productive discussion for the students; perhaps pairing up with another student to give an example.	Work with table partner to answer the questions.	15–20 min
Possible Extension	Have students use the internet to look up other types of milk and their and their differences in chemical makeup from cow's milk.			

Investigation 2: Sugar Concentration of Probiotic Cultures with a Benedict's Assay

Overview: Students will learn the skill of identifying and reducing sugar content using a Benedict's assay on various milk-based probiotic cultures.

LEARNING GOALS	ASSESSED OUTCOME	FOCUSED SKILLS
• To carry out a Benedict's Assay • To identify the sugar content of various milk-based probiotics • To identify other applications of Benedict's Assays and	Students will familiarize themselves with the biochemistry of milk products and their relative sugar levels.	• Benedict's assay • Analysis using spectrophotometry • Practicing Claim, Evidence and Reasoning protocols

SEQUENCE

ACTIVITY	MATERIAL AND DETAIL	TEACHER	STUDENTS	TIME
Lab Protocols	• **Probiotic samples**: Yakult, kefir, drinkable yogurt, Activia yogurt, probiotic milk and/or homemade probiotics • Distilled water • Benedict's reagent • Test tubes (1 per sample) • Test tube rack • Graduated pipettes • Beaker (for water bath) • Hot plate or Bunsen burner • Tongs or test-tube clamps • Timer • Marker/labels • Lab gloves and goggles	• Set up equipment and lab material for groups of 2-4 students • Review lab safety with students • Provide students with formative feedback on their results	Students will complete lab procedure using the attached lab protocols	30–45 min
Data Tables Analysis Conclusions	**See included worksheet**	Provide students with a copy of the lab protocols or make available online	Use your lab results to complete the data tables and answer the analysis questions	25–35 min
Possible Extension	Have students analyze their samples using a spectrophotometer; detailed instructions provided in **Investigation 4: Using Spectrophotometry to Generate a Standard Curve**			

Investigation 3: Casein Concentration by Bradford Assay Standard Curve from Serial Dilutions

Overview: Students will learn the skill of identifying protein (casein) concentration using a Bradford assay on various milk-based probiotic cultures.

LEARNING GOALS	ASSESSED OUTCOME	FOCUSED SKILLS
• To complete a Bradford assay • To identify the protein content, in BSA protein Standards • To identify other applications of Bradford assays	Students will familiarize themselves with the biochemistry of milk by comparing its casein protein levels, compared to BSA protein standards, using a Bradford assay and (optional) spectrophotometry.	• Bradford assay • Serial dilutions • Analysis with spectrophotometry

SEQUENCE

ACTIVITY	MATERIAL AND DETAIL	TEACHER	STUDENTS	TIME
Lab Protocols	**Bradford Assay** • BSA (2 mg/mL stock) • Bradford reagent • Distilled water • Microcentrifuge tubes • P1000 Micropipettes and tips • Cuvettes • KimWipes for cuvettes • Spectrophotometer set at 595 nm **Note:** For ease of reagent preparation for use in this lab, the Quick Start Bradford Protein Assay Kit 4 #5000204EDU can be purchased from Bio-Rad.	• Set up equipment and lab material for groups of 2-4 students. • Review lab safety with students. • Provide students with formative feedback on their results.	Students will complete lab procedure using the attached lab protocols.	45–60 min
Suggested Extension	Have students analyze their samples using a spectrophotometer; detailed instructions provided in **Investigation 4: Using Spectrophotometry** to generate a Standard Curve; tubes can be compared to published standards, but it is best to use the spectrophotometer**.**			

Investigation 4: Using Spectrophotometry to Generate a Standard Curve

Overview: Students will use spectrophotometry on serial dilutions of protein to generate a standard curve.

LEARNING GOALS	ASSESSED OUTCOME	FOCUSED SKILLS
• To analyze protein samples with spectrophotometry • To identify the protein content of various milk-based probiotics and an unknown sample • To identify other applications of spectrophotometry	Students will familiarize themselves with the use of spectrophotometry to measure protein concentrations in solution as well as calculating a standard curve using a spreadsheet.	• Analysis with spectrophotometry • Standard curve generation • Using Excel/Sheets to create a standard curve • Unknown sample concentration calculations

SEQUENCE

ACTIVITY	MATERIAL AND DETAIL	TEACHER	STUDENTS	TIME
Lab Protocols Analysis	• Completed assay results from Investigation 3 (Bradford assay) • Distilled water • Microcentrifuge tubes • P1000 Micropipettes and tips • Cuvettes • KimWipes for cuvettes • Spectrophotometer set at 595 nm **Note**: For ease of reagent preparation for use in this lab, the Quick Start Bradford Protein Assay Kit 4 #5000204EDU can be purchased from Bio-Rad.	• Set up equipment and lab material for groups of 2-4 students. • Review lab safety with students. • Provide students with formative feedback on their results.	Students will complete lab procedure using the attached lab protocols.	45–60 min
Standard Curve Analysis	Students will need a laptop or device that has MS Excel or Google Sheets. Instructions are written for MS Excel.	Provide students with a copy of the lab protocols or make available online.	Use your lab results to complete the data tables and answer the analysis questions.	35–45 min
Possible Extension	Have students come up with other applications/uses for spectrophotometry and Bradford assays. Have students come up with other applications/ uses for standard curves and how they are used in the biotech industry.			

Investigation 5: Identifying Bacteria in Different Brands of Probiotics

Overview: Students will identify the reported probiotic bacterial species found in various milk-based probiotic products.

LEARNING GOALS	ASSESSED OUTCOME	FOCUSED SKILLS
• To practice using the Internet for research • To identify the probiotic species listed as ingredients in various milk-based probiotics as well as an unknown sample	Students will familiarize themselves with the probiotics in milk-based cultures and will identify what bacteria should be present.	Web-based research of certain probiotic brands

SEQUENCE

ACTIVITY	MATERIAL AND DETAIL	TEACHER	STUDENTS	TIME
Intro Video	Show students this video ("What Is a Probiotic?" [2:39]) to pique their interest and introduce the idea of probiotics.	• Project the video. • Turn on captions for equal access for all learners.	Have students come up with one question they have after watching the video	5 min
Prelab Inquiry into Milk-based Probiotics	Provide students with a laptop or device to look up the following for Yakult, Activia, kefir, and two other examples of their choosing: 1. Choose **3 probiotic products** (bring them to class or take a picture of the label). 2. **List the bacteria** each product claims to contain. 3. Research the following for each species: • Shape (rod, round?) • Gram reaction (+ or –) • Where it's found in the body • Any health benefits	• Provide students with labels or containers for Yakult, Activia, and kefir. • Provide students with a copy of the lab protocols or make them available online.	• Students will complete pre-lab inquiry before completing the actual lab procedure. • Students may opt to save the analysis questions for this activity until after they have completed Investigations 6 and 7.	45–60 min
Possible Extension	1. Have students come up with other probiotic based foods from around the world and the history of the food in that culture. 2. Poster project extension on probiotics using the following inquiry questions: • What are probiotic products and why are they helpful? • What is the history of the development of probiotics? • What are naturally occurring probiotics and their isolation? • What are the general and mental health benefits of probiotics? • How is the use of probiotics different for animals than humans? • How are probiotics produced? • What are characteristics of probiotics? • Why is gut health important?			

Investigation 6: Serial Dilutions of Probiotic Cultures

Overview: Students will make serial dilutions of various milk-based probiotic cultures and will plate them on MRS agar plates.

LEARNING GOALSS	ASSESSED OUTCOME	FOCUSED SKILLS
• To practice making serial dilutions • To employ aseptic microbiological technique • To practice plating bacteria on agar plates	Students will familiarize themselves with serial dilutions and plating bacteria.	• Serial dilutions from a stock solution • Plating bacteria on agar plates • Aseptic technique

SEQUENCE

ACTIVITY	MATERIAL AND DETAIL	TEACHER	STUDENTS	TIME
Lab Protocols Analysis	• Gloves • Disinfectant or 70% Isopropanol • Bunsen burner • Permanent marker • 5 x microcentrifuge tubes (1.7 ml) • Micropipette (P-200) • Box of P-200 sterile tips • Bottle of sterile saline (0.11% NaCl) • Individually chosen probiotic • Tube rack • 5 x MRS agar plates • Waste tip container • Plate spreader	• Set up equipment and lab material for groups of 2-4 students. • Review lab safety with students. • Review aseptic technique. • Provide students with formative feedback on their results.	Students will complete lab procedure using the attached lab protocols.	45–60 min
Possible Extension	• Have students make their own MRS agar plates for this lab. • Calculate the original concentration of Lactobacilli in the probiotic solution by multiplying the colony count by the dilution factor, adjusting for the amount plated (100 µL). **Example:** If you observe 250 colonies on a plate that was diluted 100 times and you plated 0.1 mL, the CFU/mL would be calculated as follows: CFU/mL = (250 * 100) / 0.1 = 2,500,000 CFU/mL.			

Investigation 7: Gram Staining of Probiotic Strains

Overview: The students will learn how to complete a Gram staining protocol and use it to identify bacterial cultures in probiotic dairy products

LEARNING GOALS	ASSESSED OUTCOME	FOCUSED SKILLS
• To practice the skill of microscopy • To identify the bacterial content in various milk-based probiotics and an unknown sample • To identify other applications of Gram staining	Students will familiarize themselves with the bacterial species found in milk-based probiotics.	• Gram staining • Microscopy • Oil immersion imaging

SEQUENCE

ACTIVITY	MATERIAL AND DETAIL	TEACHER	STUDENTS	TIME
Pre-lab Inquiry questions	• Provide students with answers from Lab 5; or have them look in their lab packets. • Identifying what strains of bacteria should be present in the following probiotics.	Ask students to share what bacterial stains they are expecting to see in each of the probiotic cultures.		10–15 min
Lab Protocols Analysis	**Materials** • Crystal Violet • Iodine • Alcohol • Safranin • Bunsen Burner for heat fixing • Slides; one per sample with cover slips • Clothespin or slide clamp • Microscope with oil immersion lens • KimWipes • Immersion Oil • Wash Bottle for rinsing slides	• Set up equipment and lab material for groups of 2-4 students • Review lab safety with students • Provide students with formative feedback on their results	• Students will complete lab procedure using the attached lab protocols • Completed Inquiry answers from Investigation 5	45–60 min
Possible Extension	• Have students come up with a dichotomous key to identify the bacterial cultures. • Have students research the medical uses of Gram staining and its significance to antibiotics.			

An Introduction to Milk: The Mystery, the History, and the Microbes

Have you ever looked at a glass of milk and wondered how it ever occurred to the first humans to drink this stuff? Most mammals do not drink milk after their infant years, but we humans do. And it's history from there. At some point on the evolutionary path, a human must have looked at a sheep and thought, “I wonder how that tastes!” The rest was history. Ten thousand years ago, early humans tired of chasing their next meal and began using milk as a food source . They brought domesticated cattle and goats into the area. But there’s a catch—not everybody can work the system.

Insert lactase persistence, which is a fancy term for saying “your body does not get the message to stop drinking milk once you are grown up.” Why milk? For Pete's sake, this white substance—this is fantastic stuff. It has protein, calcium, vitamin D, and B vitamins—nature's multivitamin milkshake. Going back in time to before kale became the new black and protein bars started making a big deal out of suburban caraway-bread loaves, milk-to-go meant the concession stand had advantages. Then things went sour: we started making cheese, butter, yogurt, and ice cream. Next thing you know, milk was not only necessary but also a type of staple.

Although occasionally unpleasant, it is amazing that some people, and many people, can gulp down milk; they become rapidly inflatable balloons. Then there are some —. Why? That all comes down to the genes. This all hinges on how the lactase boss, or LCT gene, orders your body to keep producing the enzyme lactase, which allows us to digest milk's lactose sugar. In most mammals, the LCT gene turns off once they are weaned—after all, why would they leave it on? But not us. A few of our ancestors, strangely, underwent changes in a neighboring gene called MCM6, which effectively told the LCT gene, "Oh no, keep partying on with milk."

But why did drinking milk ever catch on? Because in harsh environments, milk was a reliable source until crops failed or the sun weakened. That is to say, it was a milk of survival. And fast-forward to now, dairy is a diverse and vast global industry. But here comes almond, oat, soy, and yes, potato milk—all that are elbowing in. We can perform a wide range of laboratory tests on milk to analyze its various sugars and casein proteins. It is a laboratory superstar. And yet, your body continues to either high-five dairy products or panic upon encountering them. This is what we are here to examine.

In this lab, we will milk it for all it is worth and delve into the moo-ving history, the udderly fair genetics, and the advantages of tolerating milk evolution. Expect the astonishing revelation that a paltry glass of milk has a much bigger story—about farming, food, and your funky little genes.

SOURCES

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Investigation 1: Inquiry into the Biochemistry of Milk

PART 1: Observing the Graphic

https://www.compoundchem.com/wp-content/uploads/2018/06/The-chemistry-of-milk-v2.pdf

Carefully study the "The Chemistry of Milk" infographic by Compound Interest.

1. What are the main components of milk? List at least four and their approximate percentages.

Component	Percentage
1.	
2.	
3.	
4.	

2. What is the role of casein micelles in milk?

3. Why does milk appear white, according to the graphic?

PART 2: Asking Questions

1. Write three scientific questions that this infographic makes you wonder. Try to go beyond what's directly stated.

   a. _____

   _____

   b. _____

   _____

   c. _____

   _____

2. Now highlight the question you are **most interested** in investigating further.

PART 3: Making Claims and Using Evidence

Use evidence from the infographic to answer the following:

Claim: Milk is a complex mixture, not a simple liquid.

- Evidence:
- Reasoning:

Claim: Digesting milk changes its chemistry.

- Evidence:
- Reasoning:

PART 4: Thinking Like a Biochemist

What are some real-world applications of understanding milk chemistry?

PART 5: Your Investigation Plan (Optional Extension)

Choose one question you wrote earlier. How would you investigate it?

1. What tools or tests might you use (e.g., pH test, centrifuge, heating, Benedict's test)?

2. What variables would you control?

3. What would you expect to find?

SOURCE

Brunning, A. (2018). The chemistry of milk v2 [PDF infographic]. In *Compound Interest*. https://www.compoundchem.com/wp-content/uploads/2018/06/The-chemistry-of-milk-v2.pdf

Investigation 2: Sugar Concentration of Probiotic Cultures with a Benedict's Assay

There are many neat things to learn about dairy products, and another thing we're looking at in them is sugar content—hello Benedict's Assay! A century ago, a brilliant chemist named Stanley Rossiter Benedict had a problem: He was tired of urine being boring. You see, back in the day, doctors adored testing urine for just about everything—in particular, sugar, which they used to diagnose diabetes. However, their tests were messy, erratic, and only slightly more reliable than those of a sugar-crazed toddler. So, Benedict, the guy who looked at bodily fluids and said, "I can do better than that," did what any self-respecting healer ought, and put together his magical blue brew in his laboratory. That potion, Benedict's reagent, was the OG of glucose detectors. It even changed colors dramatically whenever it sniffed out reducing sugars. The more sugar there is, the more exciting the color changes—blue to green, yellow to orange, and brick red-like a chemical fashion show. Scientists rejoiced. Diabetes testing got easier. And somewhere, there was likely a beaker tossing handfuls of glitter in the air in celebration.

But Benedict's renown didn't stop there. His tiny, blue concoction became a science-classroom legend, and it is still used today to test foods, drinks, and the occasional suspicious juice box. It's easy, quick, and appealingly colorful—a chemistry TikTok before there was TikTok. So, the next time you encounter that sky-blue liquid in a test tube, consider that you're doing more than just a sugar test. You continue the sparkly legacy of a man who made bodily fluid science weirdly glamorous.

PURPOSE

To compare and analyze the reducing sugar content in various milk-based probiotic products**,** including Kefir, Yakult, Activia**,** and homemade probiotics, using **Benedict's reagent**

MATERIALS

- Probiotic samples:
  - Yakult
  - Kefir
  - Activia yogurt
  - Probiotic milk
- Distilled water
- Benedict's reagent
- Test tubes (1 per sample)
- Test tube rack
- Graduated pipettes
- Beaker (for water bath)
- Hot plate or Bunsen burner
- Tongs or test-tube clamps
- Timer
- Marker/labels
- Lab gloves and goggles

SAFETY PRECAUTIONS

- Always wear **goggles**, **gloves**, and a **lab coat**.
- Handle hot liquids and equipment **with care**.
- **Do not ingest** any of the milk or chemical solutions.

PROCEDURES

1. **Label** each test tube with the name of the probiotic sample being tested (including **Activia**).
2. **Pipette 2 mL** of each sample into its corresponding test tube.
3. For thick samples like **Activia**, **dilute** with 1 mL of distilled water to make testing easier.

4. Add **2 mL of Benedict's reagent** to each test tube.
5. Gently **shake or swirl** to mix.
6. Prepare a **hot water bath** (~90–100°C) using a beaker on a hot plate.
7. Place the test tubes in the **water bath** using tongs or test tube holders.
8. **Heat for 5 minutes**, then remove and place in a test tube rack.
9. **Observe and record** any **color changes**:

*As an extension, students can analyze the samples using spectrophotometry; instructions are in **Investigation 4: Using Spectrophotometry to Generate a Standard Curve.**

Color	Reducing Sugar Presence
Blue	None
Green	Trace
Yellow	Low
Orange	Moderate
Brick-red	High

Sample Name	Initial Color	Final Color	Sugar Level Estimate	Absorbance at 550 au
Yakult				
Kefir				
Activia Yogurt				
Homemade Probiotic Milk				

ANALYSIS AND CONCLUSION

1. Which probiotic had the **highest reducing sugar content**?

2. How does the **texture** or **thickness** of a probiotic (like Activia) impact sugar detection?

3. Do the **nutritional labels** match your test results?

4. Why is Benedict's only helpful in **reducing sugars**, not all carbohydrates?

5. Describe how different milk-based probiotics vary in sugar content and what that means for their **nutritional value** and **fermentation level**.

SOURCES

Benedict, S. R. (1909). A reagent for the detection of reducing sugars. *Journal of Biological Chemistry*, *5*(5), pp. 485–487.

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National Center for Biotechnology Information. (YEAR). Reducing sugars and Benedict's test. *NCBI Bookshelf*, U.S. National Library of Medicine. https://www.ncbi.nlm.nih.gov

Investigation 3: Casein Concentration by Bradford Assay Standard Curve from Serial Dilutions

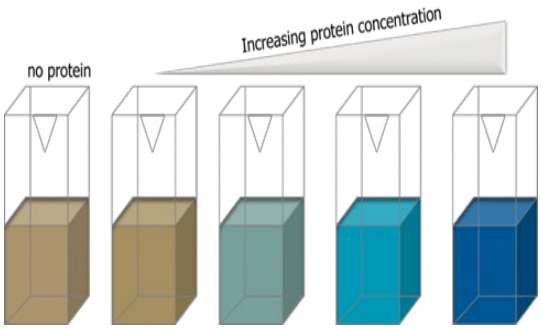
PURPOSE

To determine the protein concentration in unknown samples using the Bradford reagent and a standard curve based on known concentrations of Bovine Serum Albumin (BSA).

BACKGROUND

The Brilliantly Blue History of the Bradford Assay (A Story of Protein, Dye, and Destiny)

Long ago in a laboratory not so far away (it was, instead, in 1976), a scientist by the name of Marion M. Bradford decided she was fed up—fed up with long, senseless protein assays that seemed to drag on forever and whose number of steps rivaled those of a wedding dance. The methods of the day were too complicated. They were too cumbersome and too costly, and they used chemicals that were too dangerous. Bradford also thought: "Wouldn't it be cool if I could just throw some blue dye in a tube, add protein, and then get an instant readout?" And, like all transformative lab magic, the Bradford assay was invented—a technique so fast and straightforward that even a grad student who hadn't slept in days could perform it without destroying their thesis.



Enter: The Coomassie Dye. The hero here is Coomassie Brilliant Blue G-250, a dye that tends to show off. It turns a regal shade of deep blue when it encounters protein, particularly the noble arginine. You see, Coomassie is a lab rockstar. It not only binds to protein; it changes its entire personality or absorbance spectrum when it does so. And then it leaps like Size 18, from 465 nm to 595 nm, like: "Yes darling, I'm bound, and I'm beautiful." I love this assay because it takes less than 5 minutes and is sensitive, detecting even 1 µg of your protein (it's looking at you, tiny protein). The protein quantitation technique says, "I acknowledge your protein; I respect your protein; I will measure your protein in style."

The Bradford assay is not only a method—it's a way of life. It's a blue, bright, somewhat diva-like, dependable way to get your protein and life in order. The Bradford assay is a rapid and sensitive colorimetric method for determining protein concentrations. The dye binds to proteins, particularly arginine, shifting its peak absorbance from a brownish red (465 nm) to a blue (595 nm) wavelength. The higher the protein level, the bluer the solution. The absorbance is read at 595 nm in a spectrophotometer.

PURPOSE

To quantify an unknown, you first create a **standard curve** using serial dilutions of a known protein (like BSA).

MATERIALS

- BSA Protein Standards (#1–7)
- 1x Phosphate Buffered Saline
- Bradford reagent
- Distilled water
- Microcentrifuge tubes
- P1000 Micropipettes and tips
- P200 Micropipettes and tips
- 1-mL Cuvettes
- Spectrophotometer set at 595 nm

Note: If you are using purchased protein standards from Bio-Rad, you can skip creating the standard curve.

Serial Dilution of BSA for Standard Curve

1. **Label tubes** 1 to 7 for your dilutions (plus a blank).
2. Add **100 µL** distilled water to tubes 2–7.
3. Add **200 µL** of 1 mg/mL BSA to tube 1.
4. Serially dilute 2-fold across tubes:
   - Transfer 100 µL from tube 1 to tube 2 and mix.
   - Transfer 100 µL from tube 2 to tube 3 and mix.
   - Repeat through tube 7.
   - Tube 8 is your blank (Bradford only, no BSA).

Data Table: Protein Standards Absorbance Spectrophotometer Readings		
Tube	**BSA Conc. (µg/µL)**	**Absorbance Reading @ 595 au**
1	0.125	
2	0.25	
3	0.50	
4	0.75	
5	1.0	
6	1.5	
7	2.0	
8	0	
Kefir		
Yakult		
Activia		
Homemade		

Dilution of Probiotic Cultures

1. Prepare a 1:75 dilution of the probiotic samples using 1x PBS.
2. Label 4 microtubes with the name of each probiotic.
   a. Pipette 300 µL PBS into the labeled microtubes.
   b. Add 4 µL of probiotic into corresponding tube, and invert to mix.
3. You will use these diluted solutions to test along with your standards.
4. You will be able to determine the protein concentration of our probiotics by comparing the readings to our best fit line that will be made from the protein standards.

Bradford Assay Steps

1. In a 1.5-mL microtube:
   - Pipette 100 µL of each standard or unknown sample
   - Add 1,000 µL Bradford reagent
2. Mix gently and let sit **5–10 minutes**, but no longer than 1 hour.
3. Pipette the entire content of the microtube into a cuvette.
4. Measure **absorbance at 595 nm**.
5. Record values for each known standard.

Note: The samples and Bradford reagent are used in a 1:10 ratio.

SOURCES

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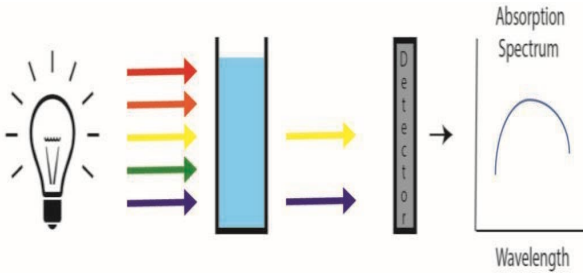
Investigation 4: Using Spectrophotometry to Generate a Standard Curve

Long ago—we're talking Issac Newton and Genesis, long ago—humans began to appreciate the excellence of light. Newton allowed white light to pass through a prism and found it wasn't dull and white; it was a rainbow in hiding. So, we awoke our obsession with light, color, and humanity, never looking at a glow stick in the same way again. So, anyway, what is spectrophotometry? Spectrophotometry is the study of: "Shining light through things and seeing how much those things don't let the light go through." In science speak, it's a way to measure how much light gets absorbed by a solution to determine how much of a substance is present in it.

The narrative of this Light-Based Brilliance began in the 1800s. When August Beer had a thought one Friday evening, he developed Beer's Law, which illustrates the relationship between absorbance and the concentration of a substance. This was something scientists were very intrigued by. And in the early 1900s, scientists began to realize that different chemicals absorb different wavelengths of light. Finally, in the 1940s, the first spectrophotometer emerged.

The world's first commercial UV-visible spectrophotometer was born, the Beckman DU, an incredible machine that could measure things you couldn't even see. Nerds everywhere rejoiced. It was a game changer—the iPhone of chemistry, only with fewer emojis and more cuvettes.

How it works is pretty straightforward—all we need is



- Light Source: "Here comes the sun!"
- Wavelength Selector (Monochromator): A Spotify for light selects one color at a time.
- Sample Holder (Cuvette): Where your mystery solution kicks back, basking in glory.
- Detector: A busy-body neighbor measuring how much light got through.
- Readout: Lets you know if your solution is perfectly transparent, a little shady, or blocks the light altogether.

This was a giant and life-changing discovery because spectrophotometry has been a gamechanger when trying to determine the amount of protein in our food, detect the amount of sugar in our food, test water quality, or even identify diseases like diabetes.

The name sounds fancy, but spectrophotometry is science's way of playing hide and seek with molecules. We shine light, they respond, and we take notes like the gossipy nerds we are.

The next time you work with a spectrophotometer, give it a nod of gratitude. After all, it's been helping scientists throw shade since the 1940s—and doing so with stunning precision.

Sources

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PART 1: How to Use a Spectrophotometer

A spectrophotometer measures the amount of light a sample absorbs. This is used to determine the concentration of a solute in solution (like protein or sugar).

MATERIALS

- Spectrophotometer
- Cuvettes (glass or plastic)
- Kimwipes or lint-free tissues
- Test samples
- Blank solution (e.g., water or reagent only

PROCEDURE:

1. Power on the spectrophotometer and allow it to warm up for 15–20 minutes (for older models).
2. Set the Wavelength using the dial or buttons to set the correct wavelength (e.g., 595 nm for protein assays).
3. Prepare the Blank by filling a clean cuvette with **the solvent or reagent** (no sample).
   - This will be used to "zero" the machine.
4. Clean the Cuvette by wiping the outside with a **Kimwipe** to remove fingerprints.
5. Zero the Spectrophotometer
   - Insert the blank into the cuvette holder (clear sides face the light).
   - Close the lid and press the "zero" or "blank" button until the absorbance reads **0.000**.
6. Insert the sample.
   - Fill a second clean cuvette with your test sample.
   - Wipe it clean and insert it into the holder as you would a blank.
7. Read and record.
   - The display will show the absorbance (A) or percent transmittance (%T).
   - Record the value in your lab notebook.
8. Remove the sample and repeat steps 6–7 for each additional sample.

CLEANUP AND SUGGESTIONS

- Rinse cuvettes with distilled water.
- Turn off the spectrophotometer.
- Never touch the clear sides of the cuvette.
- Always use the same orientation for every cuvette.

PART 2: Creating a Standard Curve in Excel

Making a Linear Standard Curve in Excel (Video)

LEARNING GOALS

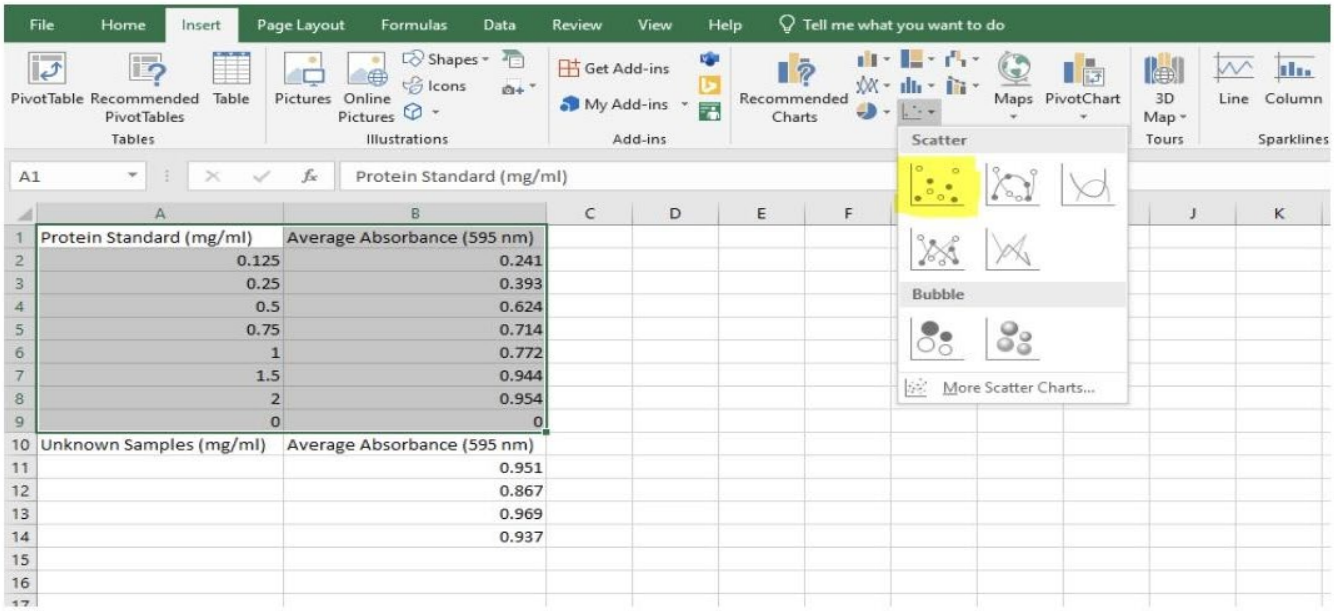
Input data into Microsoft Excel, form a graph, and find the concentration of protein in an unknown sample.

- Enter the data for protein standards and measured absorbance, including my unknown sample.
- Successfully transferred my data points into a scatter plot.
- Find the coefficient of determination, the formula, and how to add a best-fit line onto the graph.
- Use the formula from my graph to find the concentration of protein in my unknown sample.

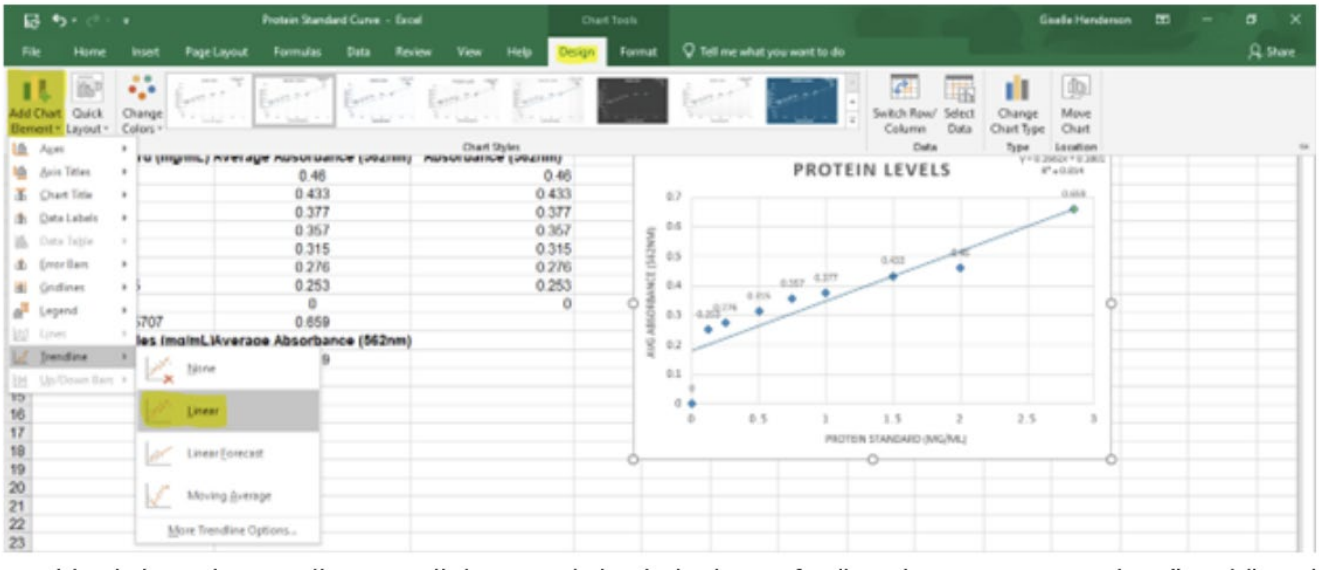
Note: Creating the graph using these instructions is easiest on the Excel desktop app, NOT the browser version.

	A	
1	Protein Standard (mg/ml)	Average Absorbance (595 nm)
2	0.125	0.241
3	0.25	0.393
4	0.5	0.624
5	0.75	0.714
6	1	0.772
7	1.5	0.944
8	2	0.954
9	0	0
10	Unknown Samples (mg/ml)	Average Absorbance (595 nm)
11		0.951
12		0.867
13		0.969
14		0.937

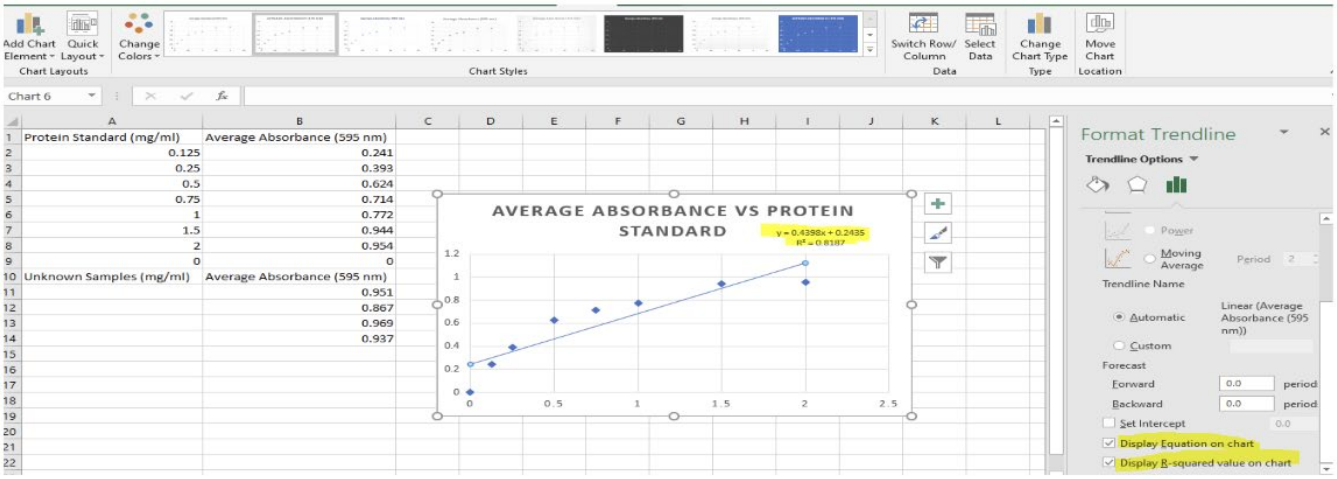
1. Enter the given protein standards into column one, and label it: “Protein Standard (mg/mL)”
2. For the next column, title it:
   *If using spectrophotometer:
   “Average Absorbance (595 nm)”
   *If using colorimeter:
   “Average Absorbance (562 nm)”
3. Enter the data you gathered when putting the standards into the colorimeter/spectrophotometer. Make sure to include a standard with 0 protein to function as a control
4. Below these, create new rows for each column, labelled “Unknown Sample (mg/mL)” and “Average Absorbance (562 nm)”. These should be next to each other.
5. In the bottom Avg. Absorbance column, enter the value measured for your unknown sample, leaving its protein measurement blank for now.
6. Select the top two columns (Protein Standard and Avg. Absorbance): To do this, hold down the curser on cell A1 and drag the curser to select all cells within the top two columns (including the titles).
7. Once you have highlighted the data, go to the “Insert” tab and select the various chart options. Hover over the scatterplot option and select the first option in the top left.



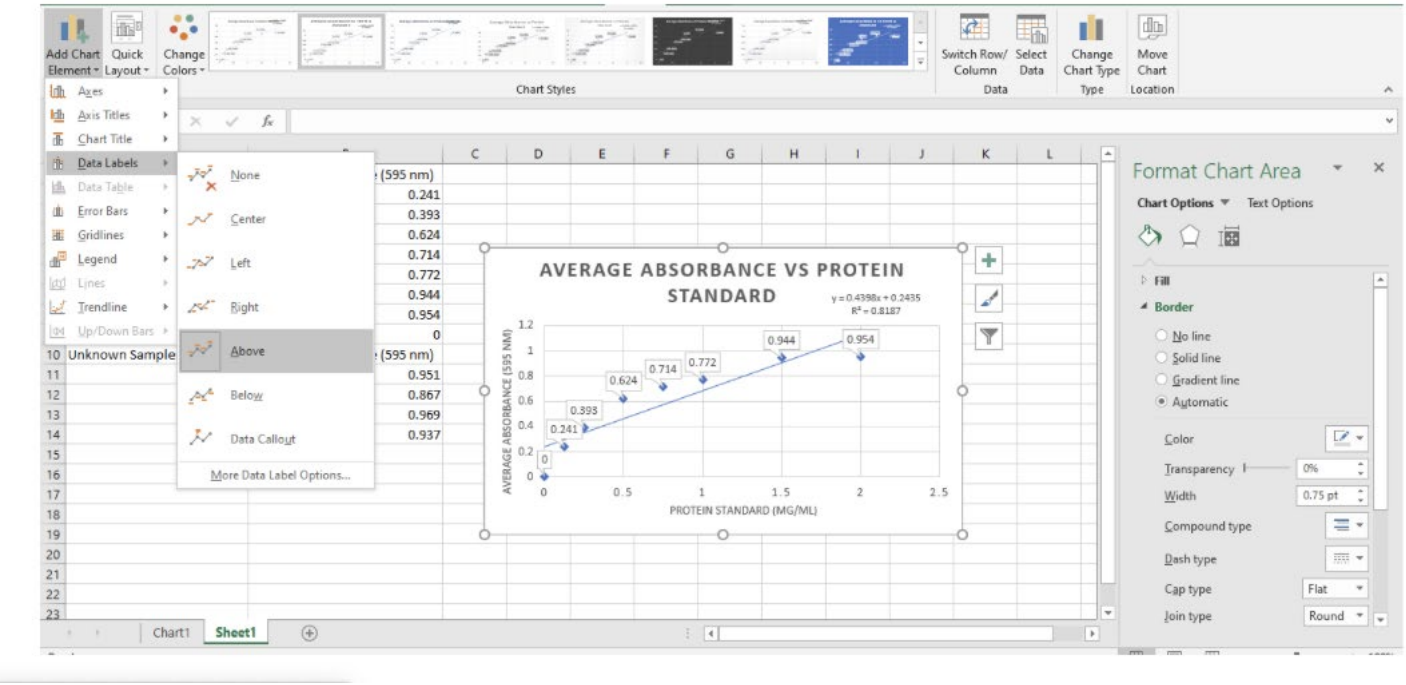
8. Click on the graph that it generated and go to the “Design” tab. From there, click on “Add Chart Element” and scroll down to the trendline option in the dropdown menu. Add a Linear trendline.



9. Double click on the trendline. Scroll down and check the boxes for “Display equation on chart” and “Display r-squared value on chart.” Adjust the layout to your liking.



10. To your chart add a title, axis names and coordinate points.
    a. **Title**: Click on the title generated and change the text to include both variables. An example is Average Absorbance vs. Protein Standards.
    b. **Axis Names**: Click on the graph and go to the *Design tab*, from there click on *Add Chart Element*. Hover over the *Axis Title*s tab and select *Primary Horizontal*. This will create your x axis which should be titled Protein Standard (mg/mL). Do the same thing but now select *Primary Vertical* and title the newly generated y axis title Avg. Absorbance (595 nm). (562 nm if using colorimeter)



c. **Coordinate Points**: Double click on one of the points on the graph and click on the Add Chart Element icon on the top left. Click on "Data Labels" and select "Above" (or any other orientation that makes it clear) to paste the y-values on the graph.

11. Using the equation it provides (the y = ...), fill in the absorbance you found for your **unknown sample as y** and solve to **find x**. This value is the concentration of protein in your sample.

Example Unknown Calculation:
Suppose a student's unknown gave an absorbance of 0.85.
Example standard curve equation: y= 0.4398x+0.2435

a. Plug in the absorbance value for the Y-coordinate.
   Y=0.4398x+0.2435
   .850=0.4398x+0.2435
b. Subtract .2435 from both sides of the equation. This will get rid of the .2435 on the right side and decrease your absorbance (y) value by .2435.
   .850=0.4398x+0.2435
   .850 **-.2435** =0.4398x+0.2435 **-.2435**
   .6065=.4398x
c. Divide both sides by .4398 to isolate the x.
   .6065=.4398x
   .6065 **/.4398**=.4398x **/.4398**
   1.379=x
   This is your answer (in mg/mL).

Do this calculation for each of the four absorbance values to figure out the protein standard of each. Fill in the blank spaces in the Excel sheet with the answers.

Investigation 5: Identifying Bacteria in Different Brands of Probiotics

What and Who's Really in Your Yogurt? Based on the Bradford assay we know various amounts of protein, but what or who is in your probiotics? Not all probiotics are what they claim to be! Your goal is to test different probiotic milk products, looking for…. You guessed it, bacteria! A Dairy-Delicious Dive Into Probiotics. *Because your yogurt might be more alive than your houseplants, it is important to investigate your* milk-based probiotics, this classic drink of strong bones, sleepy cats, and... living bacteria? That's right—your fridge isn't just home to forgotten leftovers and mystery Tupperware. If you've got yogurt, kefir, or fancy probiotic cheese in there, congratulations! You're hosting a microscopic party of **live and active cultures**.

These dairy-loving probiotics aren't the bad guys that make your milk smell like gym socks. No, no—these are the *friendly* bacteria. Think of them as the helpful neighbors in your gut, passing out digestive enzymes and quietly whispering, "Don't worry, we got this lactose situation under control."

Some common probiotic all-stars in dairy products include:

- *Lactobacillus acidophilus*—the unsung hero of your Greek yogurt
- *Bifidobacterium bifidum*—hard to pronounce, but easy on the tummy
- *Streptococcus thermophilus*—sounds terrifying, but it just wants to help

And how do they get into your yogurt? Let's just say someone mixed milk with bacteria *on purpose*, waited for it to curdle, and decided it was delicious. Humans are weird. So next time you're spooning into your creamy parfait, just remember you're not eating **just** yogurt. You're having a spoonful of science, with a side of live bacterial roommates.

Welcome to the udderly fascinating world of **dairy probiotics**. Let's milk it for all it's worth.

- What bacteria do they claim to have
- What bacteria can you grow and identify in the lab

ESSENTIAL QUESTION

Do different probiotic brands contain the bacterial strains they advertise, and how do they compare?

BACKGROUND RESEARCH (PRE-LAB):

1. Choose **3 probiotic products** (bring them to class or take a picture of the label).
2. **List the bacteria** each product claims to contain.
3. Research the following for each species:
    - Shape (rod, round?)
    - Gram reaction (+ or -)
    - Where it's found in the body
    - Any health benefits

Product Name	Claimed Bacteria	Bacterial Shape	Gram Stain results	Claimed Health Benefits
Yakult				
Kefir				
Activia				
Homemade				

Students will use their research in this investigation for their analysis of **Lab Investigation 6: Serial Dilutions of Probiotic Cultures** and **Lab Investigation 7: Gram Staining of Probiotic Strains**
Answer the following analysis after completing **Lab Investigation 6: Serial Dilutions of Probiotic Cultures** and **Lab Investigation 7: Gram Staining of Probiotic Strains.**

1. Did the bacteria you found match what the label claimed? Why or why not?

2. What limitations or errors could affect your results?

3. Which product seemed to have the most viable probiotics?

4. What do your findings say about the accuracy of supplement labels?

5. Would you trust these products more, less, or the same after this experiment?

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Investigation 6: Serial Dilutions of Probiotic Cultures

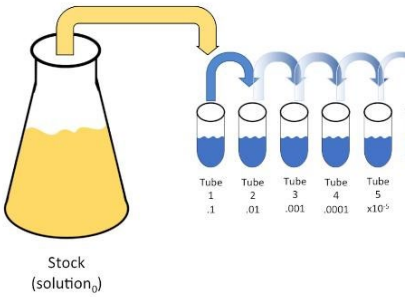
MATERIALS

- Gloves
- Disinfectant or 70% Isopropanol
- Bunsen burner
- Permanent marker
- 5 x microcentrifuge tubes (1.7 ml)
- Micropipette (P-200)
- Box of P-200 sterile tips
- Bottle of sterile saline (0.11% NaCl)
- Individually chosen probiotic
- Tube rack
- 5 x MRS agar plates
- Waste tip container
- Plate spreader

SAFETY AND PREPARATION

- Ensure a sterile work environment and proper personal protective equipment (PPE)
- Wipe down the lab bench with disinfectant.

PROCEDURES



1. **Labeling Tubes:**
   - Label five sterile tubes as 10^{-1}, 10^{-2}, 10^{-3}, 10^{-4}, and 10^{-5}.
2. **Preparation of Dilution Tubes:**
   - Pipette 900 µL of sterile saline solution into each of the five tubes
   - Using aseptic technique, flame the bottle neck and avoid contaminating the pipette tips.
3. **Initial Inoculation:**
   - Pipette 100 µL of the probiotic solution into the first tube labeled 10^{1}.
   - Mix thoroughly by flicking the tube or using a vortex mixer to ensure the sample is evenly distributed.
4. **Serial Dilutions:**
   - Using a fresh pipette tip, transfer 100 µL from the 10^{1} tube to the 10^{-2} tube.
   - Mix thoroughly, as in step 4.
   - Repeat this process sequentially from 10^{-2} to 10^{-3}, 10^{-3} to 10^{-4}, and 10^{-4} to 10^{-5}.
   - This process creates a series of 10-fold dilutions, reducing the concentration of the original sample in each subsequent tube.
5. **Labeling Agar Plates:**
   - Label five MRS agar plates with the corresponding dilution levels (10^{-1} through 10^{-5}) along the bottom edge.
   - Include the date and your initials on each plate.
6. **Inoculation of Plates**
   - Pipette 100 µL of the 10^{-5} dilution onto the surface of the agar in the plate labeled 10^{-5}.
   - Repeat for each plate, applying the appropriate dilution to the corresponding labeled plate.
7. **Spreading the Sample**
   - Use a sterile plate spreader to evenly spread the solution across the agar surface.
   - For efficiency, begin with the 10^{-5} plate and work backward to 10^{-1} to avoid contamination between samples.

8. **Incubation**
    - Stack and tape the plates together, placing them upside down (agar side up) in a 37°C incubator for 24-48 hours
    - Check plates daily to monitor the growth of Lactobacilli strains, which may initially appear as specks before developing into full colonies.
    - If there is a timing delay before proceeding to **Lab 7: Analysis of Probiotics with Gram Staining,** the plates can be placed in the refrigerator until use.
9. **Analysis of Results:**
    - After incubation, observe each plate for the growth of colonies. Count the visible colonies on plates with a manageable colony number (ideally, plates with between 30–300 colonies).
    - Isolate the plate with clear colonies; you will save this plate for **Lab 7: Analysis of Probiotics with Gram Staining.** If you have colonies that appear to be different shapes and colors, you may have multiple types of bacteria and should confirm this in lab 7, by doing a Gram stain of the various colonies

EXTENSION

Calculate the original concentration of Lactobacilli in the probiotic solution by multiplying the colony count by the dilution factor, adjusting for the amount plated (100 µL).

Example:
Volume plated (mL) x DF of the plate = Total Dilution Factor
Number of colonies counted (CFU) / Total Dilution Factor = Total CFU / mL

For example, if you counted 150 colonies on the plate with the dilution factor of 1:100. You plated 100 µL onto that plate:

Total DF = 0.1 mL x 1/100 (or 0.01) = 0.001
Total CFU = 150 / 0.001 = 150,000 CFU / mL"

In the example you gave here, there were 250 colonies (CFU) on a plate diluted 100 times (1:100) and you plated 100 microliters (0.1 mL).

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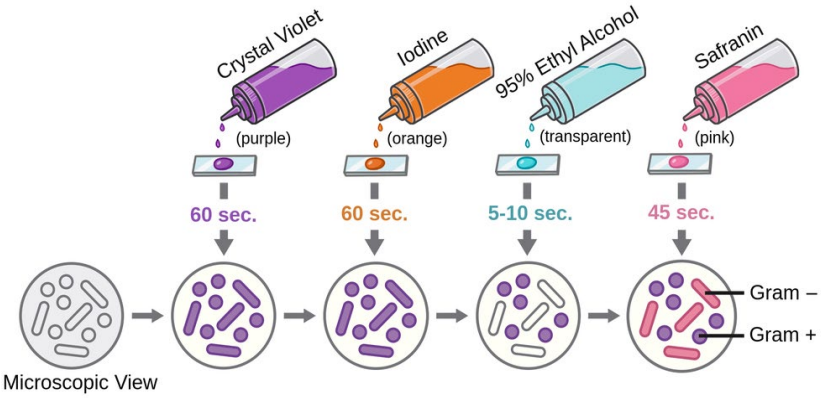
Investigation 7: Gram Staining of Probiotic Strains

Now, how do we distinguish bacteria from one another? Well, they don't wear name tags, but they *do* react differently to a cool little technique called the **Gram stain**. First conceived by Hans Christian Gram in 1884, this laboratory test is used to distinguish bacteria based on their **cell wall structure.** Today, Gram staining is one of the most used techniques in labs worldwide, which helps identify bacteria and allows practitioners to choose the right **antibiotic treatment**. Some drugs work well on Gram-positive bacteria; others target Gram-negative bacteria. Gram Staining can be broken down into 4 steps.

The Four Steps of Gram Staining:

1. **Crystal violet (purple dye)** – stains all the cells
2. **Iodine** binds the dye into thick cell walls
3. **Alcohol** (decolorizer) – washes dye out of thin-walled bacteria
4. **Safranin** (red counterstain) – stains the now colorless bacteria



The resulting slides can be contrasted by the fact that Gram-positive bacteria will take up crystal violet, while Gram-negative bacteria will not.

- **Gram-positive bacteria** → Purple (thick peptidoglycan walls)
- **Gram-negative bacteria** → Pink/red (thin walls + outer membrane)

Identifying what strains of bacteria should be present in the following probiotics

- Activia _____
- Kefir _____
- Yakult _____

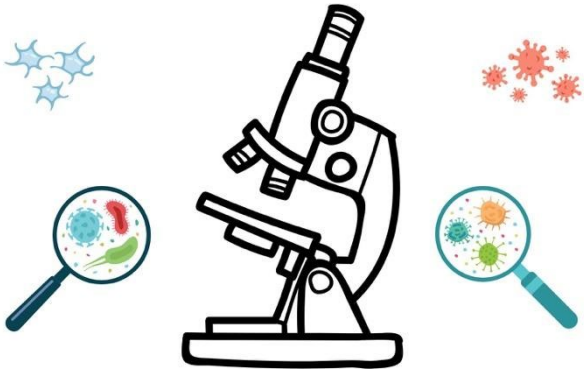
You will use your three known compositions to figure out the unknown composition of the homemade probiotic that has been prepared by your instructor. Each company has reported what strains should be in their cultures, which will enable us to compare the slide with the homemade culture and identify the bacterial strains.

Preparing the Probiotic Emulsion:

1. Label each slide with which probiotic you are isolating from; one slide from each probiotic
2. You and your lab partner will need to prepare the following slides:
3. Prepare a bacterial emulsion on each slide from solid media (agar plates):
    a. Place a small drop of water on the slide; Aseptically transfer a tiny number of bacteria and mix.
4. From liquid culture (broth), Place 3–6 loopfuls directly onto the slide. Do NOT add water.
5. Spread the mixture into a thin layer (about the size of a dime).
6. Allow slides to air dry completely before heat fixing.
7. Once dry, heat fix the slide by quickly passing it through a flame three times (bacteria side up).
    a. Let the slide cool before continuing.
8. Flood the slide with crystal violet. Stain for 1 minute, then rinse gently with water.

9. Add Iodine solution for 1 minute, then rinse gently with water.
10. Decolorize with 3–6 drops of 95% ethanol until runoff is clear, then rinse with water.
11. Counterstain with safranin for 30 seconds, then rinse with water.
12. Gently blot dry the slide if needed. Place under the microscope.
13. Use an oil immersion lens (100x) for best resolution. Add one drop of oil to the stained area.
    a. Detailed instructions are in the next lab protocol
14. Look for color (purple indicates Gram-positive, pink indicates Gram-negative) and shape (rods versus cocci).

Steps for Using the Oil Immersion Lens (100x):



1. **Start with Lower Magnification (4x or 10x)**
    - Place your slide on the stage and use the **coarse focus knob** to bring the specimen into view.
    - Move to **40x** and use the **fine focus** to sharpen the image.
2. **Move to the 100x Objective (But Don't Let It Touch Yet)**
    - Rotate the nosepiece so that the **100x oil immersion lens** is almost in place but not yet clicked in.
3. **Add a Drop of Immersion Oil**
    - Place **one small drop of immersion oil** (usually synthetic or cedar wood oil) **directly on the slide** over the area you're viewing.
4. **Carefully Rotate the 100x Lens Into Place.**
    - Swing the **100x objective** into position so that it gently touches the oil drop.
    - DO NOT use the coarse focus at this point—**only the fine focus**.
5. **Use Fine Focus to Sharpen the Image**
    - Slowly adjust the **fine focus knob** to bring the specimen into clear view.
    - Lighting may need to be increased using the **diaphragm** or **light intensity knob**.
6. **Observe and Record**
    - Examine your specimen and take notes or images as needed.
    - Move the slide slowly—at 100x, even small movements are dramatic.
7. **Clean Up After Viewing**
    - When finished, rotate the 100x lens **away** from the oil.
    - Use **lens paper and lens cleaner or alcohol** to gently wipe the oil off:
        - The **objective lens** and **stage are if oil drips**

SAFETY PRECAUTIONS

- Never use coarse focus with the 100x lens, as there is a risk of breaking the slide or damaging the lens.
- Always clean the 100x lens **immediately after use**—oil left on it can dry and damage the optics.
- Only use **immersion oil approved for microscopes.**

SOURCE

Pakpour, N., & Horgan, S. (n.d.). *Lab 3: Simple, negative, and gram stain.* Biology LibreTexts. https://bio.libretexts.org/Learning_Objects/Laboratory_Experiments/Microbiology_Labs/Book%3A_General_Microbiology_Lab_Manual_(Pakpour_and_Horgan)/Lab_03%3A_Simple_Negative_and_Gram_Stain

Probiotic Gram Stain Observation Worksheet

In this lab, you will observe bacterial samples from various probiotic products using Gram staining. Use the table below to record your observations and determine if the bacteria are Gram-positive or Gram-negative.

Sample Name	Color After Staining	Bacterial Shape (Cocci/Rods/etc.)	Gram Reaction (+ or -)	Notes/Observations
Yakult				
Activia				
Kefir				
Unknown				

Analysis Questions

1. Which product had the most visible bacteria?

2. Were all the bacteria Gram-positive? If not, what might that suggest?

3. Did the observed bacterial shapes match what you expected from a probiotic product?

4. What conclusions can you make about the quality or contents of each product?

5. How might this information help consumers make choices about probiotics?

Active Reading & Annotating in Science

Teacher Version

Menu of Annotation Strategies

1. Double underline/highlight the central ideas or conclusions of the text. *(9-12.RST.2)*
2. Put a check mark by and underline the textual evidence that supports the central idea or conclusion of the text (there may be more than one piece of evidence). *(9-12.RST.1)*
3. In the margins of the text, please summarize the text's explanation of the complex process/ phenomenon/concept. *(9-12.RST.2)*
4. Put a star by the specific results based on the explanation of the text. *(9-12.RST. 3)*
5. Circle specific symbols, key terms and science-specific words/phrases and define these in the margins. *(9-12.RST.4)*
6. Put boxes around sections of text that could fit into distinct categories, and label these. If the text is already sectioned with headings and subheadings, paraphrase each of them (headings and subheadings). *(9-12.RST.5)*
7. On a separate piece of paper, take quantitative or technical information expressed in words and put it into a visual form (e.g., a table or chart), and take visual or mathematical information and summarize into words. *(9-10.RST.7)*
8. When you have finished the entire reading, at the bottom or back of the page, respond to these three prompts:
    a. Write what you think is the purpose of the text. *(9-12.RST.6)*
    b. Connect anything you have read in this text to anything you have learned in your science class or any other readings. Write those connections. *(9-12.RST.9)*
    c. Explain how this text addressed a question or solved a problem. *(11-12.RST.7)*
        i. How well do you think the text answered the question or solved the problem?
        ii. What gaps or missing information did you find in the text? *(11-12.RST.1)*

RST: Reading Standards for Literacy in Science and Technical Subjects 6–12, pp. 83–84

Recommended Instructional Practices with This Resource

- Depending on the learning goal or type of reading, assign students specific annotation strategies that fit best.
- In collaborative groups, students are assigned different annotation strategies (i.e., student a = 1, 2; student b = 3, 4; student c = 5, 6; student d = 7). After the students share their findings with their strategies, have the students answer the prompts in annotation 8 together or individually.
- In collaborative groups, break up the sections of the article to assign to different students in the group with teacher-selected annotation strategies (strategy #3 highly recommended for this

activity); students share the content of their section with their group members as the group members take notes. Students then answer the prompts in #8 together or individually.

Note: It is recommended for students to do a first read without annotating, and then apply the annotation strategies for the second read.

Models of different annotating strategies using “Ocean Acidification” article

Active Reading & Annotating in Science

Student Version

The purpose of "Active Reading & Annotating Science" is to help you better understand what you read and think critically. To do this, you must think carefully about what you are reading while paying attention to your own understanding. Remember, these strategies are designed to help you analyze and understand the text, as well as acquire scientific information.

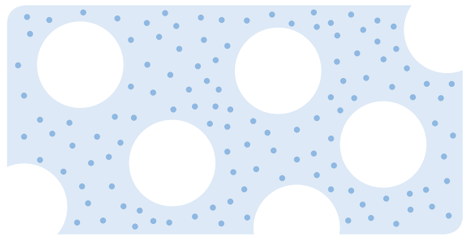
Menu of Annotation Strategies

1. **Double underline/highlight** the central ideas or conclusions of the text. *(9-12.RST.2)*
2. In the **margins** of the text, please summarize the text's explanation of the complex process/ phenomenon/concept. *(9-12.RST.2)*
3. Put a **checkmark** by and **underline** the textual evidence that supports the central idea or conclusion of the text (there may be more than one piece of evidence). *(9-12.RST.1)*
4. Put a **star** by the specific results based on the explanation of the text. *(9-12.RST. 3)*
5. Circle specific symbols, key terms and science-specific words/phrases and define these in the margins. *(9-12.RST.4)*
6. Put **boxes** around sections of text that could fit into distinct categories, and label these. If the text is already sectioned with headings and subheadings, paraphrase each of them (headings and subheadings). *(9-12.RST.5)*
7. On a **separate piece of paper**, take quantitative or technical information expressed in words and put it into a visual form (e.g. a table or chart), and take visual or mathematical information and summarize it into words. *(9-10.RST.7)*
8. When you have finished the entire reading, at the bottom or back of the page, respond to these three prompts:
    a. Write what you think is the purpose of the text. *(9-12.RST.6)*
    b. Connect anything you have read in this text to anything you have learned in your science class or any other readings. Write down those connections. *(9-12.RST.9)*
    c. Explain how this text addressed a question or solved a problem. *(11-12.RST.7)*
        i. How well do you think the text answered the question or solved the problem?
        ii. What gaps or missing information did you find in the text? *(11-12.RST.1)*

THE CHEMISTRY OF COW'S MILK

MILK'S COMPOSITION

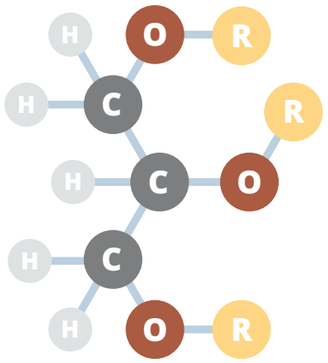
Milk is an emulsion of fat in water. It is also a colloidal suspension of proteins. Other compounds, including lactose and minerals, are fully dissolved in the solution.



WATER	87.5%
FAT	3.9%
PROTEINS	3.4%
LACTOSE & MINERALS	5.2%

FATS IN MILK

Droplets of fat in milk have an average size of 3–4 micrometres. They consist mainly of triglycerides, and also contain fat-soluble vitamins.



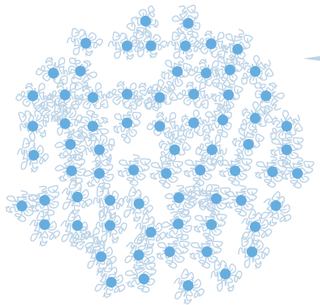
TRIGLYCERIDE

R = FATTY ACID MOLECULES

PALMITIC ACID	23.6–31.4%
OLEIC ACID	14.9–22.0%
STEARIC ACID	10.4–14.6%
MYRISTIC ACID	9.1–11.9%

WHY IS MILK WHITE?

Milk contains hundreds of types of protein, of which casein is the main type. The milk proteins form micelles. These micelles scatter light, causing milk to appear white.



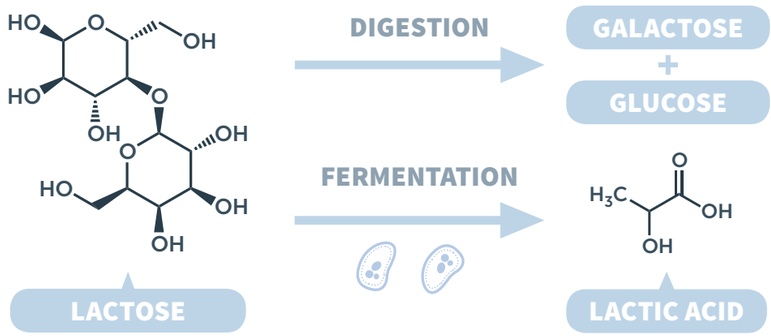
CASEIN MICELLES

There are several models of casein micelle structure. This diagram shows the supramolecular structure.

- CASEIN PROTEINS
- CALCIUM PHOSPHATE CLUSTER

LACTOSE & MILK

Lactose is a sugar found in milk. People who are lactose intolerant are unable to digest it. Lactose can be fermented by microorganisms to form lactic acid, causing the milk to sour.



KIT SAFETY DATA SHEET

Kit Product Name Quick Start Bradford Protein Assay Kit 4

Kit Catalog Number(s) 5000204, 5000204EDU

Revision date 18-Jul-2023

Kit Contents

Catalog Number(s)	Product Name
5000208, 9704888	Bovine Gamma Globulin, 2 mg/ml Std.
9704887	Bovine Gamma Globulin, 1.5 mg/ml
9704886	Bovine Gamma Globulin, 1 mg/ml
9704885	Bovine Gamma Globulin, 0.75 mg/ml
9704884	Bovine Gamma Globulin, 0.5 mg/ml
9704883	Bovine Gamma Globulin, 0.25 mg/ml
9704882	Bovine Gamma Globulin, 0.125 mg/ml
5000205, 5000205EDU	Quick Start Bradford Reagent, 1X

SAFETY DATA SHEET

Revision date 18-Jul-2023 **Revision Number** 1.1

1. Identification

Product identifier

Product Name Bovine Gamma Globulin, 2 mg/ml Std.

Other means of identification

Catalog Number(s) 5000208, 9704888

Recommended use of the chemical and restrictions on use

Recommended use Laboratory chemicals

Details of the supplier of the safety data sheet

Corporate Headquarters	Manufacturer Address	Legal Entity / Contact Address
Bio-Rad Laboratories Inc. 1000 Alfred Nobel Drive Hercules, CA 94547 USA	Bio-Rad Laboratories, Life Science Group 2000 Alfred Nobel Drive Hercules, California 94547 USA	Bio-Rad Laboratories Life Science 2000 Alfred Nobel Drive Hercules, California 94547

Technical Service 1-800-424-6723
support@bio-rad.com

Emergency telephone number

24 Hour Emergency Phone Number CHEMTREC USA: 1 (800) 424-9300

2. Hazard(s) identification

Classification

This chemical is not considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200).

Hazards not otherwise classified (HNOC)
Not applicable

Label elements

Hazard statements
This chemical is not considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200).

The product contains no substances which at their given concentration, are considered to be hazardous to health.

Appearance aqueous solution **Physical state** Liquid **Odor** Odorless

Other information
Contains animal source material. (Cattle).

3. Composition/information on ingredients

Substance

Not applicable.

Mixture

The product contains no substances which at their given concentration, are considered to be hazardous to health

*The exact percentage (concentration) of composition has been withheld as a trade secret.

4. First-aid measures

Description of first aid measures

Inhalation Remove to fresh air.

Eye contact Rinse thoroughly with plenty of water for at least 15 minutes, lifting lower and upper eyelids. Consult a physician.

Skin contact Wash skin with soap and water.

Ingestion Rinse mouth.

Most important symptoms and effects, both acute and delayed

Symptoms No information available.

Indication of any immediate medical attention and special treatment needed

Note to physicians Treat symptomatically.

5. Fire-fighting measures

Suitable Extinguishing Media Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.

Specific hazards arising from the chemical No information available.

Explosion data

Sensitivity to mechanical impact None.

Sensitivity to static discharge None.

Special protective equipment and precautions for fire-fighters Firefighters should wear self-contained breathing apparatus and full firefighting turnout gear. Use personal protection equipment.

6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

Personal precautions Ensure adequate ventilation.

Methods and material for containment and cleaning up

Methods for containment Prevent further leakage or spillage if safe to do so.

Methods for cleaning up Pick up and transfer to properly labeled containers.

7. Handling and storage

Precautions for safe handling

Advice on safe handling Handle in accordance with good industrial hygiene and safety practice.

Conditions for safe storage, including any incompatibilities

Storage Conditions Store according to product and label instructions.

8. Exposure controls/personal protection

Control parameters

Exposure Limits This product, as supplied, does not contain any hazardous materials with occupational exposure limits established by the region specific regulatory bodies.

Appropriate engineering controls

Engineering controls Showers
Eyewash stations
Ventilation systems.

Individual protection measures, such as personal protective equipment

Eye/face protection No special protective equipment required.

Skin and body protection No special protective equipment required.

Respiratory protection No protective equipment is needed under normal use conditions. If exposure limits are exceeded or irritation is experienced, ventilation and evacuation may be required.

General hygiene considerations Handle in accordance with good industrial hygiene and safety practice.

9. Physical and chemical properties

Information on basic physical and chemical properties

Physical state	Liquid
Appearance	aqueous solution
Color	colorless
Odor	Odorless
Odor threshold	No information available

Property	**Values**	**Remarks • Method**
pH	6.9	
Melting point / freezing point	No data available	None known
Boiling point / boiling range	100 °C / 212 °F	

Flash point	No data available	None known
Evaporation rate	No data available	None known
Flammability (solid, gas)	No data available	None known
Flammability Limit in Air		None known
Upper flammability or explosive limits	No data available	
Lower flammability or explosive limits	No data available	
Vapor pressure	No data available	None known
Vapor density	No data available	None known
Relative density	No data available	None known
Water solubility	Miscible in water	
Solubility(ies)	No data available	None known
Partition coefficient	No data available	None known
Autoignition temperature	No data available	None known
Decomposition temperature	No data available	None known
Kinematic viscosity	No data available	None known
Dynamic viscosity	No data available	None known

Other information

Explosive properties	No information available
Oxidizing properties	No information available
Softening point	No information available
Molecular weight	No information available
VOC content	No information available
Liquid Density	No information available
Bulk density	No information available

10. Stability and reactivity

Reactivity No information available.

Chemical stability Stable under normal conditions.

Possibility of hazardous reactions Avoid contact with metals. This product contains sodium azide. Sodium azide can react with copper, brass, lead, and solder in piping systems to form explosive compounds and toxic gases.

Conditions to avoid None known based on information supplied.

Incompatible materials Metals.

Hazardous decomposition products None known based on information supplied.

11. Toxicological information

Information on likely routes of exposure

Inhalation Specific test data for the substance or mixture is not available.

Eye contact Specific test data for the substance or mixture is not available.

Skin contact Specific test data for the substance or mixture is not available.

Ingestion Specific test data for the substance or mixture is not available.

Symptoms related to the physical, chemical and toxicological characteristics

Symptoms No information available.

Acute toxicity

Numerical measures of toxicity

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Skin corrosion/irritation	No information available.
Serious eye damage/eye irritation	No information available.
Respiratory or skin sensitization	No information available.
Germ cell mutagenicity	No information available.
Carcinogenicity	No information available.
Reproductive toxicity	No information available.
STOT - single exposure	No information available.
STOT - repeated exposure	No information available.
Aspiration hazard	No information available.
Other adverse effects	No information available.
Interactive effects	No information available.

12. Ecological information

Ecotoxicity	The environmental impact of this product has not been fully investigated.
Persistence and degradability	No information available.
Bioaccumulation	There is no data for this product.
Other adverse effects	No information available.

13. Disposal considerations

Waste treatment methods

Waste from residues/unused products	Dispose of in accordance with local regulations. Dispose of waste in accordance with environmental legislation. Flush pipes with water frequently if discarding solutions containing sodium azide into metal piping systems.

Contaminated packaging Do not reuse empty containers.

14. Transport information

DOT Not regulated

TDG Not regulated

MEX Not regulated

IATA Not regulated

IMDG Not regulated

15. Regulatory information

International Inventories Contact supplier for inventory compliance status

US Federal Regulations

SARA 313
Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA). This product does not contain any chemicals which are subject to the reporting requirements of the Act and Title 40 of the Code of Federal Regulations, Part 372.

SARA 311/312 Hazard Categories
Should this product meet EPCRA 311/312 Tier reporting criteria at 40 CFR 370, refer to Section 2 of this SDS for appropriate classifications.

CWA (Clean Water Act)
This product does not contain any substances regulated as pollutants pursuant to the Clean Water Act (40 CFR 122.21 and 40 CFR 122.42).

CERCLA
This material, as supplied, does not contain any substances regulated as hazardous substances under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302) or the Superfund Amendments and Reauthorization Act (SARA) (40 CFR 355). There may be specific reporting requirements at the local, regional, or state level pertaining to releases of this material.

US State Regulations

California Proposition 65
This product does not contain any Proposition 65 chemicals.

U.S. State Right-to-Know Regulations

Chemical name	New Jersey	Massachusetts	Pennsylvania
Water 7732-18-5	-	-	X
Sodium azide 26628-22-8	X	X	X

U.S. EPA Label Information

EPA Pesticide Registration Number Not applicable

16. Other information

NFPA	**Health hazards** 0	**Flammability** 0	**Instability** 0	**Special hazards** -
HMIS	**Health hazards** 0	**Flammability** 0	**Physical hazards** 0	**Personal protection** X

Key or legend to abbreviations and acronyms used in the safety data sheet

Legend Section 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

TWA	TWA (time-weighted average)	STEL	STEL (Short Term Exposure Limit)
Ceiling	Maximum limit value	*	Skin designation

Key literature references and sources for data used to compile the SDS

Agency for Toxic Substances and Disease Registry (ATSDR)
U.S. Environmental Protection Agency ChemView Database
European Food Safety Authority (EFSA)
EPA (Environmental Protection Agency)
Acute Exposure Guideline Level(s) (AEGL(s))
U.S. Environmental Protection Agency Federal Insecticide, Fungicide, and Rodenticide Act
U.S. Environmental Protection Agency High Production Volume Chemicals
Food Research Journal
Hazardous Substance Database
International Uniform Chemical Information Database (IUCLID)
National Institute of Technology and Evaluation (NITE)
Australia National Industrial Chemicals Notification and Assessment Scheme (NICNAS)
NIOSH (National Institute for Occupational Safety and Health)
National Library of Medicine's ChemID Plus (NLM CIP)
National Library of Medicine’s PubMed database (NLM PUBMED)
National Toxicology Program (NTP)
New Zealand's Chemical Classification and Information Database (CCID)
Organization for Economic Co-operation and Development Environment, Health, and Safety Publications
Organization for Economic Co-operation and Development High Production Volume Chemicals Program
Organization for Economic Co-operation and Development Screening Information Data Set
World Health Organization

Revision date	18-Jul-2023
Revision Note	Reformatted and updated existing information.

Disclaimer

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.

End of Safety Data Sheet

SAFETY DATA SHEET

Revision date 18-Jul-2023 **Revision Number** 1

1. Identification

Product identifier

Product Name Bovine Gamma Globulin, 1.5 mg/ml

Other means of identification

Catalog Number(s) 9704887

Recommended use of the chemical and restrictions on use

Recommended use Laboratory chemicals

Details of the supplier of the safety data sheet

Corporate Headquarters	Manufacturer Address	Legal Entity / Contact Address
Bio-Rad Laboratories Inc. 1000 Alfred Nobel Drive Hercules, CA 94547 USA	Bio-Rad Laboratories, Life Science Group 2000 Alfred Nobel Drive Hercules, California 94547 USA	Bio-Rad Laboratories Life Science 2000 Alfred Nobel Drive Hercules, California 94547

Technical Service 1-800-424-6723
support@bio-rad.com

Emergency telephone number

24 Hour Emergency Phone Number CHEMTREC USA: 1 (800) 424-9300

2. Hazard(s) identification

Classification

This chemical is not considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200).

Hazards not otherwise classified (HNOC)
Not applicable

Label elements

Hazard statements
This chemical is not considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200).

The product contains no substances which at their given concentration, are considered to be hazardous to health.

Appearance aqueous solution **Physical state** Liquid **Odor** Odorless

Other information
Contains animal source material. (Cattle).

3. Composition/information on ingredients

Substance

Not applicable.

Mixture

The product contains no substances which at their given concentration, are considered to be hazardous to health

*The exact percentage (concentration) of composition has been withheld as a trade secret.

4. First-aid measures

Description of first aid measures

Inhalation Remove to fresh air.

Eye contact Rinse thoroughly with plenty of water for at least 15 minutes, lifting lower and upper eyelids. Consult a physician.

Skin contact Wash skin with soap and water.

Ingestion Rinse mouth.

Most important symptoms and effects, both acute and delayed

Symptoms No information available.

Indication of any immediate medical attention and special treatment needed

Note to physicians Treat symptomatically.

5. Fire-fighting measures

Suitable Extinguishing Media Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.

Specific hazards arising from the chemical No information available.

Explosion data

Sensitivity to mechanical impact None.

Sensitivity to static discharge None.

Special protective equipment and precautions for fire-fighters Firefighters should wear self-contained breathing apparatus and full firefighting turnout gear. Use personal protection equipment.

6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

Personal precautions Ensure adequate ventilation.

Methods and material for containment and cleaning up

Methods for containment Prevent further leakage or spillage if safe to do so.

Methods for cleaning up Pick up and transfer to properly labeled containers.

7. Handling and storage

Precautions for safe handling

Advice on safe handling Handle in accordance with good industrial hygiene and safety practice.

Conditions for safe storage, including any incompatibilities

Storage Conditions Store according to product and label instructions.

8. Exposure controls/personal protection

Control parameters

Exposure Limits This product, as supplied, does not contain any hazardous materials with occupational exposure limits established by the region specific regulatory bodies.

Appropriate engineering controls

Engineering controls Showers
Eyewash stations
Ventilation systems.

Individual protection measures, such as personal protective equipment

Eye/face protection No special protective equipment required.

Skin and body protection No special protective equipment required.

Respiratory protection No protective equipment is needed under normal use conditions. If exposure limits are exceeded or irritation is experienced, ventilation and evacuation may be required.

General hygiene considerations Handle in accordance with good industrial hygiene and safety practice.

9. Physical and chemical properties

Information on basic physical and chemical properties

Physical state	Liquid
Appearance	aqueous solution
Color	colorless
Odor	Odorless
Odor threshold	No information available

Property	**Values**	**Remarks • Method**
pH	6.9	
Melting point / freezing point	0 °C / 32 °F	
Boiling point / boiling range	100 °C / 212 °F	

Flash point	No data available	None known
Evaporation rate	No data available	None known
Flammability (solid, gas)	No data available	None known
Flammability Limit in Air		None known
Upper flammability or explosive limits	No data available	
Lower flammability or explosive limits	No data available	
Vapor pressure	No data available	None known
Vapor density	No data available	None known
Relative density	No data available	None known
Water solubility	Miscible in water	
Solubility(ies)	No data available	None known
Partition coefficient	No data available	None known
Autoignition temperature	No data available	None known
Decomposition temperature	No data available	None known
Kinematic viscosity	No data available	None known
Dynamic viscosity	No data available	None known

Other information

Explosive properties	No information available
Oxidizing properties	No information available
Softening point	No information available
Molecular weight	No information available
VOC content	No information available
Liquid Density	No information available
Bulk density	No information available

10. Stability and reactivity

Reactivity No information available.

Chemical stability Stable under normal conditions.

Possibility of hazardous reactions Avoid contact with metals. This product contains sodium azide. Sodium azide can react with copper, brass, lead, and solder in piping systems to form explosive compounds and toxic gases.

Conditions to avoid None known based on information supplied.

Incompatible materials Metals.

Hazardous decomposition products None known based on information supplied.

11. Toxicological information

Information on likely routes of exposure

Inhalation Specific test data for the substance or mixture is not available.

Eye contact Specific test data for the substance or mixture is not available.

Skin contact Specific test data for the substance or mixture is not available.

Ingestion Specific test data for the substance or mixture is not available.

Symptoms related to the physical, chemical and toxicological characteristics

Symptoms No information available.

Acute toxicity

Numerical measures of toxicity

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Skin corrosion/irritation	No information available.
Serious eye damage/eye irritation	No information available.
Respiratory or skin sensitization	No information available.
Germ cell mutagenicity	No information available.
Carcinogenicity	No information available.
Reproductive toxicity	No information available.
STOT - single exposure	No information available.
STOT - repeated exposure	No information available.
Aspiration hazard	No information available.
Other adverse effects	No information available.
Interactive effects	No information available.

12. Ecological information

Ecotoxicity	The environmental impact of this product has not been fully investigated.
Persistence and degradability	No information available.
Bioaccumulation	There is no data for this product.
Other adverse effects	No information available.

13. Disposal considerations

Waste treatment methods

Waste from residues/unused products	Dispose of in accordance with local regulations. Dispose of waste in accordance with environmental legislation. Flush pipes with water frequently if discarding solutions containing sodium azide into metal piping systems.

Contaminated packaging Do not reuse empty containers.

14. Transport information

DOT Not regulated

TDG Not regulated

MEX Not regulated

IATA Not regulated

IMDG Not regulated

15. Regulatory information

International Inventories Contact supplier for inventory compliance status

US Federal Regulations

SARA 313
Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA). This product does not contain any chemicals which are subject to the reporting requirements of the Act and Title 40 of the Code of Federal Regulations, Part 372.

SARA 311/312 Hazard Categories
Should this product meet EPCRA 311/312 Tier reporting criteria at 40 CFR 370, refer to Section 2 of this SDS for appropriate classifications.

CWA (Clean Water Act)
This product does not contain any substances regulated as pollutants pursuant to the Clean Water Act (40 CFR 122.21 and 40 CFR 122.42).

CERCLA
This material, as supplied, does not contain any substances regulated as hazardous substances under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302) or the Superfund Amendments and Reauthorization Act (SARA) (40 CFR 355). There may be specific reporting requirements at the local, regional, or state level pertaining to releases of this material.

US State Regulations

California Proposition 65
This product does not contain any Proposition 65 chemicals.

U.S. State Right-to-Know Regulations

Chemical name	New Jersey	Massachusetts	Pennsylvania
Water 7732-18-5	-	-	X
Sodium azide 26628-22-8	X	X	X

U.S. EPA Label Information

EPA Pesticide Registration Number Not applicable

16. Other information

NFPA	**Health hazards** 0	**Flammability** 0	**Instability** 0	**Special hazards** -
HMIS	**Health hazards** 0	**Flammability** 0	**Physical hazards** 0	**Personal protection** X

Key or legend to abbreviations and acronyms used in the safety data sheet

Legend Section 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

TWA	TWA (time-weighted average)	STEL	STEL (Short Term Exposure Limit)
Ceiling	Maximum limit value	*	Skin designation

Key literature references and sources for data used to compile the SDS

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U.S. Environmental Protection Agency ChemView Database
European Food Safety Authority (EFSA)
EPA (Environmental Protection Agency)
Acute Exposure Guideline Level(s) (AEGL(s))
U.S. Environmental Protection Agency Federal Insecticide, Fungicide, and Rodenticide Act
U.S. Environmental Protection Agency High Production Volume Chemicals
Food Research Journal
Hazardous Substance Database
International Uniform Chemical Information Database (IUCLID)
National Institute of Technology and Evaluation (NITE)
Australia National Industrial Chemicals Notification and Assessment Scheme (NICNAS)
NIOSH (National Institute for Occupational Safety and Health)
National Library of Medicine's ChemID Plus (NLM CIP)
National Library of Medicine’s PubMed database (NLM PUBMED)
National Toxicology Program (NTP)
New Zealand's Chemical Classification and Information Database (CCID)
Organization for Economic Co-operation and Development Environment, Health, and Safety Publications
Organization for Economic Co-operation and Development High Production Volume Chemicals Program
Organization for Economic Co-operation and Development Screening Information Data Set
World Health Organization

Revision date	18-Jul-2023
Revision Note	Significant changes throughout SDS. Review all sections.

Disclaimer

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.

End of Safety Data Sheet

SAFETY DATA SHEET

Revision date 18-Jul-2023 **Revision Number** 1

1. Identification

Product identifier

Product Name Bovine Gamma Globulin, 1 mg/ml

Other means of identification

Catalog Number(s) 9704886

Recommended use of the chemical and restrictions on use

Recommended use Laboratory chemicals

Details of the supplier of the safety data sheet

Corporate Headquarters	Manufacturer Address	Legal Entity / Contact Address
Bio-Rad Laboratories Inc. 1000 Alfred Nobel Drive Hercules, CA 94547 USA	Bio-Rad Laboratories, Life Science Group 2000 Alfred Nobel Drive Hercules, California 94547 USA	Bio-Rad Laboratories Life Science 2000 Alfred Nobel Drive Hercules, California 94547

Technical Service 1-800-424-6723
support@bio-rad.com

Emergency telephone number

24 Hour Emergency Phone Number CHEMTREC USA: 1 (800) 424-9300

2. Hazard(s) identification

Classification

This chemical is not considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200).

Hazards not otherwise classified (HNOC)
Not applicable

Label elements

Hazard statements
This chemical is not considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200).

The product contains no substances which at their given concentration, are considered to be hazardous to health.

Appearance aqueous solution **Physical state** Liquid **Odor** Odorless

Other information
Contains animal source material. (Cattle).

3. Composition/information on ingredients

Substance

Not applicable.

Mixture

The product contains no substances which at their given concentration, are considered to be hazardous to health

*The exact percentage (concentration) of composition has been withheld as a trade secret.

4. First-aid measures

Description of first aid measures

Inhalation Remove to fresh air.

Eye contact Rinse thoroughly with plenty of water for at least 15 minutes, lifting lower and upper eyelids. Consult a physician.

Skin contact Wash skin with soap and water.

Ingestion Rinse mouth.

Most important symptoms and effects, both acute and delayed

Symptoms No information available.

Indication of any immediate medical attention and special treatment needed

Note to physicians Treat symptomatically.

5. Fire-fighting measures

Suitable Extinguishing Media Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.

Specific hazards arising from the chemical No information available.

Explosion data

Sensitivity to mechanical impact None.

Sensitivity to static discharge None.

Special protective equipment and precautions for fire-fighters Firefighters should wear self-contained breathing apparatus and full firefighting turnout gear. Use personal protection equipment.

6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

Personal precautions Ensure adequate ventilation.

Methods and material for containment and cleaning up

Methods for containment Prevent further leakage or spillage if safe to do so.

Methods for cleaning up Pick up and transfer to properly labeled containers.

7. Handling and storage

Precautions for safe handling

Advice on safe handling Handle in accordance with good industrial hygiene and safety practice.

Conditions for safe storage, including any incompatibilities

Storage Conditions Store according to product and label instructions.

8. Exposure controls/personal protection

Control parameters

Exposure Limits This product, as supplied, does not contain any hazardous materials with occupational exposure limits established by the region specific regulatory bodies.

Appropriate engineering controls

Engineering controls Showers
Eyewash stations
Ventilation systems.

Individual protection measures, such as personal protective equipment

Eye/face protection No special protective equipment required.

Skin and body protection No special protective equipment required.

Respiratory protection No protective equipment is needed under normal use conditions. If exposure limits are exceeded or irritation is experienced, ventilation and evacuation may be required.

General hygiene considerations Handle in accordance with good industrial hygiene and safety practice.

9. Physical and chemical properties

Information on basic physical and chemical properties

Physical state	Liquid
Appearance	aqueous solution
Color	colorless
Odor	Odorless
Odor threshold	No information available

Property	**Values**	**Remarks • Method**
pH	6.9	
Melting point / freezing point	0 °C / 32 °F	
Boiling point / boiling range	100 °C / 212 °F	

Flash point	No data available	None known
Evaporation rate	No data available	None known
Flammability (solid, gas)	No data available	None known
Flammability Limit in Air		None known
Upper flammability or explosive limits	No data available	
Lower flammability or explosive limits	No data available	
Vapor pressure	No data available	None known
Vapor density	No data available	None known
Relative density	No data available	None known
Water solubility	Miscible in water	
Solubility(ies)	No data available	None known
Partition coefficient	No data available	None known
Autoignition temperature	No data available	None known
Decomposition temperature	No data available	None known
Kinematic viscosity	No data available	None known
Dynamic viscosity	No data available	None known

Other information

Explosive properties	No information available
Oxidizing properties	No information available
Softening point	No information available
Molecular weight	No information available
VOC content	No information available
Liquid Density	No information available
Bulk density	No information available

10. Stability and reactivity

Reactivity No information available.

Chemical stability Stable under normal conditions.

Possibility of hazardous reactions Avoid contact with metals. This product contains sodium azide. Sodium azide can react with copper, brass, lead, and solder in piping systems to form explosive compounds and toxic gases.

Conditions to avoid None known based on information supplied.

Incompatible materials Metals.

Hazardous decomposition products None known based on information supplied.

11. Toxicological information

Information on likely routes of exposure

Inhalation Specific test data for the substance or mixture is not available.

Eye contact Specific test data for the substance or mixture is not available.

Skin contact Specific test data for the substance or mixture is not available.

Ingestion Specific test data for the substance or mixture is not available.

Symptoms related to the physical, chemical and toxicological characteristics

Symptoms No information available.

Acute toxicity

Numerical measures of toxicity

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Skin corrosion/irritation	No information available.
Serious eye damage/eye irritation	No information available.
Respiratory or skin sensitization	No information available.
Germ cell mutagenicity	No information available.
Carcinogenicity	No information available.
Reproductive toxicity	No information available.
STOT - single exposure	No information available.
STOT - repeated exposure	No information available.
Aspiration hazard	No information available.
Other adverse effects	No information available.
Interactive effects	No information available.

12. Ecological information

Ecotoxicity	The environmental impact of this product has not been fully investigated.
Persistence and degradability	No information available.
Bioaccumulation	There is no data for this product.
Other adverse effects	No information available.

13. Disposal considerations

Waste treatment methods

Waste from residues/unused products	Dispose of in accordance with local regulations. Dispose of waste in accordance with environmental legislation. Flush pipes with water frequently if discarding solutions containing sodium azide into metal piping systems.

Contaminated packaging Do not reuse empty containers.

14. Transport information

DOT Not regulated

TDG Not regulated

MEX Not regulated

IATA Not regulated

IMDG Not regulated

15. Regulatory information

International Inventories Contact supplier for inventory compliance status

US Federal Regulations

SARA 313
Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA). This product does not contain any chemicals which are subject to the reporting requirements of the Act and Title 40 of the Code of Federal Regulations, Part 372.

SARA 311/312 Hazard Categories
Should this product meet EPCRA 311/312 Tier reporting criteria at 40 CFR 370, refer to Section 2 of this SDS for appropriate classifications.

CWA (Clean Water Act)
This product does not contain any substances regulated as pollutants pursuant to the Clean Water Act (40 CFR 122.21 and 40 CFR 122.42).

CERCLA
This material, as supplied, does not contain any substances regulated as hazardous substances under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302) or the Superfund Amendments and Reauthorization Act (SARA) (40 CFR 355). There may be specific reporting requirements at the local, regional, or state level pertaining to releases of this material.

US State Regulations

California Proposition 65
This product does not contain any Proposition 65 chemicals.

U.S. State Right-to-Know Regulations

Chemical name	New Jersey	Massachusetts	Pennsylvania
Water 7732-18-5	-	-	X
Sodium azide 26628-22-8	X	X	X

U.S. EPA Label Information

EPA Pesticide Registration Number Not applicable

16. Other information

NFPA	**Health hazards**	0	**Flammability**	0	**Instability** 0	**Special hazards**	-
HMIS	**Health hazards**	0	**Flammability**	0	**Physical hazards** 0	**Personal protection**	X

Key or legend to abbreviations and acronyms used in the safety data sheet

Legend Section 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

TWA	TWA (time-weighted average)	STEL	STEL (Short Term Exposure Limit)
Ceiling	Maximum limit value	*	Skin designation

Key literature references and sources for data used to compile the SDS

Agency for Toxic Substances and Disease Registry (ATSDR)
U.S. Environmental Protection Agency ChemView Database
European Food Safety Authority (EFSA)
EPA (Environmental Protection Agency)
Acute Exposure Guideline Level(s) (AEGL(s))
U.S. Environmental Protection Agency Federal Insecticide, Fungicide, and Rodenticide Act
U.S. Environmental Protection Agency High Production Volume Chemicals
Food Research Journal
Hazardous Substance Database
International Uniform Chemical Information Database (IUCLID)
National Institute of Technology and Evaluation (NITE)
Australia National Industrial Chemicals Notification and Assessment Scheme (NICNAS)
NIOSH (National Institute for Occupational Safety and Health)
National Library of Medicine's ChemID Plus (NLM CIP)
National Library of Medicine’s PubMed database (NLM PUBMED)
National Toxicology Program (NTP)
New Zealand's Chemical Classification and Information Database (CCID)
Organization for Economic Co-operation and Development Environment, Health, and Safety Publications
Organization for Economic Co-operation and Development High Production Volume Chemicals Program
Organization for Economic Co-operation and Development Screening Information Data Set
World Health Organization

Revision date	18-Jul-2023
Revision Note	Significant changes throughout SDS. Review all sections.

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End of Safety Data Sheet

SAFETY DATA SHEET

Revision date 18-Jul-2023 **Revision Number** 1

1. Identification

Product identifier

Product Name Bovine Gamma Globulin, 0.75 mg/ml

Other means of identification

Catalog Number(s) 9704885

Recommended use of the chemical and restrictions on use

Recommended use Laboratory chemicals

Details of the supplier of the safety data sheet

Corporate Headquarters	Manufacturer Address	Legal Entity / Contact Address
Bio-Rad Laboratories Inc. 1000 Alfred Nobel Drive Hercules, CA 94547 USA	Bio-Rad Laboratories, Life Science Group 2000 Alfred Nobel Drive Hercules, California 94547 USA	Bio-Rad Laboratories Life Science 2000 Alfred Nobel Drive Hercules, California 94547

Technical Service 1-800-424-6723
support@bio-rad.com

Emergency telephone number

24 Hour Emergency Phone Number CHEMTREC USA: 1 (800) 424-9300

2. Hazard(s) identification

Classification

This chemical is not considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200).

Hazards not otherwise classified (HNOC)
Not applicable

Label elements

Hazard statements
This chemical is not considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200).

The product contains no substances which at their given concentration, are considered to be hazardous to health.

Appearance aqueous solution **Physical state** Liquid **Odor** Odorless

Other information
Contains animal source material. (Cattle).

3. Composition/information on ingredients

Substance

Not applicable.

Mixture

The product contains no substances which at their given concentration, are considered to be hazardous to health

*The exact percentage (concentration) of composition has been withheld as a trade secret.

4. First-aid measures

Description of first aid measures

Inhalation Remove to fresh air.

Eye contact Rinse thoroughly with plenty of water for at least 15 minutes, lifting lower and upper eyelids. Consult a physician.

Skin contact Wash skin with soap and water.

Ingestion Rinse mouth.

Most important symptoms and effects, both acute and delayed

Symptoms No information available.

Indication of any immediate medical attention and special treatment needed

Note to physicians Treat symptomatically.

5. Fire-fighting measures

Suitable Extinguishing Media Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.

Specific hazards arising from the chemical No information available.

Explosion data

Sensitivity to mechanical impact None.

Sensitivity to static discharge None.

Special protective equipment and precautions for fire-fighters Firefighters should wear self-contained breathing apparatus and full firefighting turnout gear. Use personal protection equipment.

6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

Personal precautions Ensure adequate ventilation.

Methods and material for containment and cleaning up

Methods for containment Prevent further leakage or spillage if safe to do so.

Methods for cleaning up Pick up and transfer to properly labeled containers.

7. Handling and storage

Precautions for safe handling

Advice on safe handling Handle in accordance with good industrial hygiene and safety practice.

Conditions for safe storage, including any incompatibilities

Storage Conditions Store according to product and label instructions.

8. Exposure controls/personal protection

Control parameters

Exposure Limits This product, as supplied, does not contain any hazardous materials with occupational exposure limits established by the region specific regulatory bodies.

Appropriate engineering controls

Engineering controls Showers
Eyewash stations
Ventilation systems.

Individual protection measures, such as personal protective equipment

Eye/face protection No special protective equipment required.

Skin and body protection No special protective equipment required.

Respiratory protection No protective equipment is needed under normal use conditions. If exposure limits are exceeded or irritation is experienced, ventilation and evacuation may be required.

General hygiene considerations Handle in accordance with good industrial hygiene and safety practice.

9. Physical and chemical properties

Information on basic physical and chemical properties

Physical state	Liquid
Appearance	aqueous solution
Color	colorless
Odor	Odorless
Odor threshold	No information available

Property	**Values**	**Remarks • Method**
pH	6.9	
Melting point / freezing point	0 °C / 32 °F	
Boiling point / boiling range	100 °C / 212 °F	

Flash point	No data available	None known
Evaporation rate	No data available	None known
Flammability (solid, gas)	No data available	None known
Flammability Limit in Air		None known
Upper flammability or explosive limits	No data available	
Lower flammability or explosive limits	No data available	
Vapor pressure	No data available	None known
Vapor density	No data available	None known
Relative density	No data available	None known
Water solubility	Miscible in water	
Solubility(ies)	No data available	None known
Partition coefficient	No data available	None known
Autoignition temperature	No data available	None known
Decomposition temperature	No data available	None known
Kinematic viscosity	No data available	None known
Dynamic viscosity	No data available	None known

Other information

Explosive properties	No information available
Oxidizing properties	No information available
Softening point	No information available
Molecular weight	No information available
VOC content	No information available
Liquid Density	No information available
Bulk density	No information available

10. Stability and reactivity

Reactivity No information available.

Chemical stability Stable under normal conditions.

Possibility of hazardous reactions Avoid contact with metals. This product contains sodium azide. Sodium azide can react with copper, brass, lead, and solder in piping systems to form explosive compounds and toxic gases.

Conditions to avoid None known based on information supplied.

Incompatible materials Metals.

Hazardous decomposition products None known based on information supplied.

11. Toxicological information

Information on likely routes of exposure

Inhalation Specific test data for the substance or mixture is not available.

Eye contact Specific test data for the substance or mixture is not available.

Skin contact Specific test data for the substance or mixture is not available.

Ingestion Specific test data for the substance or mixture is not available.

Symptoms related to the physical, chemical and toxicological characteristics

Symptoms No information available.

Acute toxicity

Numerical measures of toxicity

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Skin corrosion/irritation	No information available.
Serious eye damage/eye irritation	No information available.
Respiratory or skin sensitization	No information available.
Germ cell mutagenicity	No information available.
Carcinogenicity	No information available.
Reproductive toxicity	No information available.
STOT - single exposure	No information available.
STOT - repeated exposure	No information available.
Aspiration hazard	No information available.
Other adverse effects	No information available.
Interactive effects	No information available.

12. Ecological information

Ecotoxicity	The environmental impact of this product has not been fully investigated.
Persistence and degradability	No information available.
Bioaccumulation	There is no data for this product.
Other adverse effects	No information available.

13. Disposal considerations

Waste treatment methods

Waste from residues/unused products	Dispose of in accordance with local regulations. Dispose of waste in accordance with environmental legislation. Flush pipes with water frequently if discarding solutions containing sodium azide into metal piping systems.

Contaminated packaging Do not reuse empty containers.

14. Transport information

DOT Not regulated

TDG Not regulated

MEX Not regulated

IATA Not regulated

IMDG Not regulated

15. Regulatory information

International Inventories Contact supplier for inventory compliance status

US Federal Regulations

SARA 313
Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA). This product does not contain any chemicals which are subject to the reporting requirements of the Act and Title 40 of the Code of Federal Regulations, Part 372.

SARA 311/312 Hazard Categories
Should this product meet EPCRA 311/312 Tier reporting criteria at 40 CFR 370, refer to Section 2 of this SDS for appropriate classifications.

CWA (Clean Water Act)
This product does not contain any substances regulated as pollutants pursuant to the Clean Water Act (40 CFR 122.21 and 40 CFR 122.42).

CERCLA
This material, as supplied, does not contain any substances regulated as hazardous substances under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302) or the Superfund Amendments and Reauthorization Act (SARA) (40 CFR 355). There may be specific reporting requirements at the local, regional, or state level pertaining to releases of this material.

US State Regulations

California Proposition 65
This product does not contain any Proposition 65 chemicals.

U.S. State Right-to-Know Regulations

Chemical name	New Jersey	Massachusetts	Pennsylvania
Water 7732-18-5	-	-	X
Sodium azide 26628-22-8	X	X	X

U.S. EPA Label Information

EPA Pesticide Registration Number Not applicable

16. Other information

NFPA	**Health hazards**	0	**Flammability**	0	**Instability**	0	**Special hazards** -
HMIS	**Health hazards**	0	**Flammability**	0	**Physical hazards**	0	**Personal protection** X

Key or legend to abbreviations and acronyms used in the safety data sheet

Legend Section 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

TWA	TWA (time-weighted average)	STEL	STEL (Short Term Exposure Limit)
Ceiling	Maximum limit value	*	Skin designation

Key literature references and sources for data used to compile the SDS

Agency for Toxic Substances and Disease Registry (ATSDR)
U.S. Environmental Protection Agency ChemView Database
European Food Safety Authority (EFSA)
EPA (Environmental Protection Agency)
Acute Exposure Guideline Level(s) (AEGL(s))
U.S. Environmental Protection Agency Federal Insecticide, Fungicide, and Rodenticide Act
U.S. Environmental Protection Agency High Production Volume Chemicals
Food Research Journal
Hazardous Substance Database
International Uniform Chemical Information Database (IUCLID)
National Institute of Technology and Evaluation (NITE)
Australia National Industrial Chemicals Notification and Assessment Scheme (NICNAS)
NIOSH (National Institute for Occupational Safety and Health)
National Library of Medicine's ChemID Plus (NLM CIP)
National Library of Medicine’s PubMed database (NLM PUBMED)
National Toxicology Program (NTP)
New Zealand's Chemical Classification and Information Database (CCID)
Organization for Economic Co-operation and Development Environment, Health, and Safety Publications
Organization for Economic Co-operation and Development High Production Volume Chemicals Program
Organization for Economic Co-operation and Development Screening Information Data Set
World Health Organization

Revision date	18-Jul-2023
Revision Note	Significant changes throughout SDS. Review all sections.

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End of Safety Data Sheet

SAFETY DATA SHEET

Revision date 18-Jul-2023 **Revision Number** 1

1. Identification

Product identifier

Product Name Bovine Gamma Globulin, 0.5 mg/ml

Other means of identification

Catalog Number(s) 9704884

Recommended use of the chemical and restrictions on use

Recommended use Laboratory chemicals

Details of the supplier of the safety data sheet

Corporate Headquarters	Manufacturer Address	Legal Entity / Contact Address
Bio-Rad Laboratories Inc. 1000 Alfred Nobel Drive Hercules, CA 94547 USA	Bio-Rad Laboratories, Life Science Group 2000 Alfred Nobel Drive Hercules, California 94547 USA	Bio-Rad Laboratories Life Science 2000 Alfred Nobel Drive Hercules, California 94547

Technical Service 1-800-424-6723
support@bio-rad.com

Emergency telephone number

24 Hour Emergency Phone Number CHEMTREC USA: 1 (800) 424-9300

2. Hazard(s) identification

Classification

This chemical is not considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200).

Hazards not otherwise classified (HNOC)
Not applicable

Label elements

Hazard statements
This chemical is not considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200).

The product contains no substances which at their given concentration, are considered to be hazardous to health.

Appearance aqueous solution **Physical state** Liquid **Odor** Odorless

Other information
Contains animal source material. (Cattle).

3. Composition/information on ingredients

Substance

Not applicable.

Mixture

The product contains no substances which at their given concentration, are considered to be hazardous to health

*The exact percentage (concentration) of composition has been withheld as a trade secret.

4. First-aid measures

Description of first aid measures

Inhalation Remove to fresh air.

Eye contact Rinse thoroughly with plenty of water for at least 15 minutes, lifting lower and upper eyelids. Consult a physician.

Skin contact Wash skin with soap and water.

Ingestion Rinse mouth.

Most important symptoms and effects, both acute and delayed

Symptoms No information available.

Indication of any immediate medical attention and special treatment needed

Note to physicians Treat symptomatically.

5. Fire-fighting measures

Suitable Extinguishing Media Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.

Specific hazards arising from the chemical No information available.

Explosion data

Sensitivity to mechanical impact None.

Sensitivity to static discharge None.

Special protective equipment and precautions for fire-fighters Firefighters should wear self-contained breathing apparatus and full firefighting turnout gear. Use personal protection equipment.

6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

Personal precautions Ensure adequate ventilation.

Methods and material for containment and cleaning up

Methods for containment Prevent further leakage or spillage if safe to do so.

Methods for cleaning up Pick up and transfer to properly labeled containers.

7. Handling and storage

Precautions for safe handling

Advice on safe handling Handle in accordance with good industrial hygiene and safety practice.

Conditions for safe storage, including any incompatibilities

Storage Conditions Store according to product and label instructions.

8. Exposure controls/personal protection

Control parameters

Exposure Limits This product, as supplied, does not contain any hazardous materials with occupational exposure limits established by the region specific regulatory bodies.

Appropriate engineering controls

Engineering controls Showers
Eyewash stations
Ventilation systems.

Individual protection measures, such as personal protective equipment

Eye/face protection No special protective equipment required.

Skin and body protection No special protective equipment required.

Respiratory protection No protective equipment is needed under normal use conditions. If exposure limits are exceeded or irritation is experienced, ventilation and evacuation may be required.

General hygiene considerations Handle in accordance with good industrial hygiene and safety practice.

9. Physical and chemical properties

Information on basic physical and chemical properties

Physical state	Liquid
Appearance	aqueous solution
Color	colorless
Odor	Odorless
Odor threshold	No information available

Property	**Values**	**Remarks • Method**
pH	6.9	
Melting point / freezing point	0 °C / 32 °F	
Boiling point / boiling range	100 °C / 212 °F	

Flash point	No data available	None known
Evaporation rate	No data available	None known
Flammability (solid, gas)	No data available	None known
Flammability Limit in Air		None known
Upper flammability or explosive limits	No data available	
Lower flammability or explosive limits	No data available	
Vapor pressure	No data available	None known
Vapor density	No data available	None known
Relative density	No data available	None known
Water solubility	Miscible in water	
Solubility(ies)	No data available	None known
Partition coefficient	No data available	None known
Autoignition temperature	No data available	None known
Decomposition temperature	No data available	None known
Kinematic viscosity	No data available	None known
Dynamic viscosity	No data available	None known

Other information

Explosive properties	No information available
Oxidizing properties	No information available
Softening point	No information available
Molecular weight	No information available
VOC content	No information available
Liquid Density	No information available
Bulk density	No information available

10. Stability and reactivity

Reactivity No information available.

Chemical stability Stable under normal conditions.

Possibility of hazardous reactions Avoid contact with metals. This product contains sodium azide. Sodium azide can react with copper, brass, lead, and solder in piping systems to form explosive compounds and toxic gases.

Conditions to avoid None known based on information supplied.

Incompatible materials Metals.

Hazardous decomposition products None known based on information supplied.

11. Toxicological information

Information on likely routes of exposure

Inhalation Specific test data for the substance or mixture is not available.

Eye contact Specific test data for the substance or mixture is not available.

Skin contact Specific test data for the substance or mixture is not available.

Ingestion Specific test data for the substance or mixture is not available.

Symptoms related to the physical, chemical and toxicological characteristics

Symptoms No information available.

Acute toxicity

Numerical measures of toxicity

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Skin corrosion/irritation	No information available.
Serious eye damage/eye irritation	No information available.
Respiratory or skin sensitization	No information available.
Germ cell mutagenicity	No information available.
Carcinogenicity	No information available.
Reproductive toxicity	No information available.
STOT - single exposure	No information available.
STOT - repeated exposure	No information available.
Aspiration hazard	No information available.
Other adverse effects	No information available.
Interactive effects	No information available.

12. Ecological information

Ecotoxicity	The environmental impact of this product has not been fully investigated.
Persistence and degradability	No information available.
Bioaccumulation	There is no data for this product.
Other adverse effects	No information available.

13. Disposal considerations

Waste treatment methods

Waste from residues/unused products	Dispose of in accordance with local regulations. Dispose of waste in accordance with environmental legislation. Flush pipes with water frequently if discarding solutions containing sodium azide into metal piping systems.

Contaminated packaging Do not reuse empty containers.

14. Transport information

DOT Not regulated

TDG Not regulated

MEX Not regulated

IATA Not regulated

IMDG Not regulated

15. Regulatory information

International Inventories Contact supplier for inventory compliance status

US Federal Regulations

SARA 313
Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA). This product does not contain any chemicals which are subject to the reporting requirements of the Act and Title 40 of the Code of Federal Regulations, Part 372.

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CWA (Clean Water Act)
This product does not contain any substances regulated as pollutants pursuant to the Clean Water Act (40 CFR 122.21 and 40 CFR 122.42).

CERCLA
This material, as supplied, does not contain any substances regulated as hazardous substances under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302) or the Superfund Amendments and Reauthorization Act (SARA) (40 CFR 355). There may be specific reporting requirements at the local, regional, or state level pertaining to releases of this material.

US State Regulations

California Proposition 65
This product does not contain any Proposition 65 chemicals.

U.S. State Right-to-Know Regulations

Chemical name	New Jersey	Massachusetts	Pennsylvania
Water 7732-18-5	-	-	X
Sodium azide 26628-22-8	X	X	X

U.S. EPA Label Information

EPA Pesticide Registration Number Not applicable

16. Other information

NFPA	**Health hazards**	0	**Flammability**	0	**Instability** 0	**Special hazards**	-
HMIS	**Health hazards**	0	**Flammability**	0	**Physical hazards** 0	**Personal protection**	X

Key or legend to abbreviations and acronyms used in the safety data sheet

Legend Section 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

TWA	TWA (time-weighted average)	STEL	STEL (Short Term Exposure Limit)
Ceiling	Maximum limit value	*	Skin designation

Key literature references and sources for data used to compile the SDS

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EPA (Environmental Protection Agency)
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U.S. Environmental Protection Agency Federal Insecticide, Fungicide, and Rodenticide Act
U.S. Environmental Protection Agency High Production Volume Chemicals
Food Research Journal
Hazardous Substance Database
International Uniform Chemical Information Database (IUCLID)
National Institute of Technology and Evaluation (NITE)
Australia National Industrial Chemicals Notification and Assessment Scheme (NICNAS)
NIOSH (National Institute for Occupational Safety and Health)
National Library of Medicine's ChemID Plus (NLM CIP)
National Library of Medicine’s PubMed database (NLM PUBMED)
National Toxicology Program (NTP)
New Zealand's Chemical Classification and Information Database (CCID)
Organization for Economic Co-operation and Development Environment, Health, and Safety Publications
Organization for Economic Co-operation and Development High Production Volume Chemicals Program
Organization for Economic Co-operation and Development Screening Information Data Set
World Health Organization

Revision date	18-Jul-2023
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End of Safety Data Sheet

SAFETY DATA SHEET

Revision date 18-Jul-2023 **Revision Number** 1

1. Identification

Product identifier

Product Name Bovine Gamma Globulin, 0.25 mg/ml

Other means of identification

Catalog Number(s) 9704883

Recommended use of the chemical and restrictions on use

Recommended use Laboratory chemicals

Details of the supplier of the safety data sheet

Corporate Headquarters	Manufacturer Address	Legal Entity / Contact Address
Bio-Rad Laboratories Inc. 1000 Alfred Nobel Drive Hercules, CA 94547 USA	Bio-Rad Laboratories, Life Science Group 2000 Alfred Nobel Drive Hercules, California 94547 USA	Bio-Rad Laboratories Life Science 2000 Alfred Nobel Drive Hercules, California 94547

Technical Service 1-800-424-6723
support@bio-rad.com

Emergency telephone number

24 Hour Emergency Phone Number CHEMTREC USA: 1 (800) 424-9300

2. Hazard(s) identification

Classification

This chemical is not considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200).

Hazards not otherwise classified (HNOC)
Not applicable

Label elements

Hazard statements
This chemical is not considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200).

The product contains no substances which at their given concentration, are considered to be hazardous to health.

Appearance aqueous solution **Physical state** Liquid **Odor** Odorless

Other information
Contains animal source material. (Cattle).

3. Composition/information on ingredients

Substance

Not applicable.

Mixture

The product contains no substances which at their given concentration, are considered to be hazardous to health

*The exact percentage (concentration) of composition has been withheld as a trade secret.

4. First-aid measures

Description of first aid measures

Inhalation Remove to fresh air.

Eye contact Rinse thoroughly with plenty of water for at least 15 minutes, lifting lower and upper eyelids. Consult a physician.

Skin contact Wash skin with soap and water.

Ingestion Rinse mouth.

Most important symptoms and effects, both acute and delayed

Symptoms No information available.

Indication of any immediate medical attention and special treatment needed

Note to physicians Treat symptomatically.

5. Fire-fighting measures

Suitable Extinguishing Media Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.

Specific hazards arising from the chemical No information available.

Explosion data

Sensitivity to mechanical impact None.

Sensitivity to static discharge None.

Special protective equipment and precautions for fire-fighters Firefighters should wear self-contained breathing apparatus and full firefighting turnout gear. Use personal protection equipment.

6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

Personal precautions Ensure adequate ventilation.

Methods and material for containment and cleaning up

Methods for containment Prevent further leakage or spillage if safe to do so.

Methods for cleaning up Pick up and transfer to properly labeled containers.

7. Handling and storage

Precautions for safe handling

Advice on safe handling Handle in accordance with good industrial hygiene and safety practice.

Conditions for safe storage, including any incompatibilities

Storage Conditions Store according to product and label instructions.

8. Exposure controls/personal protection

Control parameters

Exposure Limits This product, as supplied, does not contain any hazardous materials with occupational exposure limits established by the region specific regulatory bodies.

Appropriate engineering controls

Engineering controls Showers
Eyewash stations
Ventilation systems.

Individual protection measures, such as personal protective equipment

Eye/face protection No special protective equipment required.

Skin and body protection No special protective equipment required.

Respiratory protection No protective equipment is needed under normal use conditions. If exposure limits are exceeded or irritation is experienced, ventilation and evacuation may be required.

General hygiene considerations Handle in accordance with good industrial hygiene and safety practice.

9. Physical and chemical properties

Information on basic physical and chemical properties

Physical state	Liquid
Appearance	aqueous solution
Color	colorless
Odor	Odorless
Odor threshold	No information available

Property	**Values**	**Remarks • Method**
pH	6.9	
Melting point / freezing point	0 °C / 32 °F	
Boiling point / boiling range	100 °C / 212 °F	

Flash point	No data available	None known
Evaporation rate	No data available	None known
Flammability (solid, gas)	No data available	None known
Flammability Limit in Air		None known
Upper flammability or explosive limits	No data available	
Lower flammability or explosive limits	No data available	
Vapor pressure	No data available	None known
Vapor density	No data available	None known
Relative density	No data available	None known
Water solubility	Miscible in water	
Solubility(ies)	No data available	None known
Partition coefficient	No data available	None known
Autoignition temperature	No data available	None known
Decomposition temperature	No data available	None known
Kinematic viscosity	No data available	None known
Dynamic viscosity	No data available	None known

Other information

Explosive properties	No information available
Oxidizing properties	No information available
Softening point	No information available
Molecular weight	No information available
VOC content	No information available
Liquid Density	No information available
Bulk density	No information available

10. Stability and reactivity

Reactivity No information available.

Chemical stability Stable under normal conditions.

Possibility of hazardous reactions Avoid contact with metals. This product contains sodium azide. Sodium azide can react with copper, brass, lead, and solder in piping systems to form explosive compounds and toxic gases.

Conditions to avoid None known based on information supplied.

Incompatible materials Metals.

Hazardous decomposition products None known based on information supplied.

11. Toxicological information

Information on likely routes of exposure

Inhalation Specific test data for the substance or mixture is not available.

Eye contact Specific test data for the substance or mixture is not available.

Skin contact Specific test data for the substance or mixture is not available.

Ingestion Specific test data for the substance or mixture is not available.

Symptoms related to the physical, chemical and toxicological characteristics

Symptoms No information available.

Acute toxicity

Numerical measures of toxicity

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Skin corrosion/irritation	No information available.
Serious eye damage/eye irritation	No information available.
Respiratory or skin sensitization	No information available.
Germ cell mutagenicity	No information available.
Carcinogenicity	No information available.
Reproductive toxicity	No information available.
STOT - single exposure	No information available.
STOT - repeated exposure	No information available.
Aspiration hazard	No information available.
Other adverse effects	No information available.
Interactive effects	No information available.

12. Ecological information

Ecotoxicity	The environmental impact of this product has not been fully investigated.
Persistence and degradability	No information available.
Bioaccumulation	There is no data for this product.
Other adverse effects	No information available.

13. Disposal considerations

Waste treatment methods

Waste from residues/unused products	Dispose of in accordance with local regulations. Dispose of waste in accordance with environmental legislation. Flush pipes with water frequently if discarding solutions containing sodium azide into metal piping systems.

Contaminated packaging Do not reuse empty containers.

14. Transport information

DOT Not regulated

TDG Not regulated

MEX Not regulated

IATA Not regulated

IMDG Not regulated

15. Regulatory information

International Inventories Contact supplier for inventory compliance status

US Federal Regulations

SARA 313
Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA). This product does not contain any chemicals which are subject to the reporting requirements of the Act and Title 40 of the Code of Federal Regulations, Part 372.

SARA 311/312 Hazard Categories
Should this product meet EPCRA 311/312 Tier reporting criteria at 40 CFR 370, refer to Section 2 of this SDS for appropriate classifications.

CWA (Clean Water Act)
This product does not contain any substances regulated as pollutants pursuant to the Clean Water Act (40 CFR 122.21 and 40 CFR 122.42).

CERCLA
This material, as supplied, does not contain any substances regulated as hazardous substances under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302) or the Superfund Amendments and Reauthorization Act (SARA) (40 CFR 355). There may be specific reporting requirements at the local, regional, or state level pertaining to releases of this material.

US State Regulations

California Proposition 65
This product does not contain any Proposition 65 chemicals.

U.S. State Right-to-Know Regulations

Chemical name	New Jersey	Massachusetts	Pennsylvania
Water 7732-18-5	-	-	X
Sodium azide 26628-22-8	X	X	X

U.S. EPA Label Information

EPA Pesticide Registration Number Not applicable

16. Other information

NFPA	**Health hazards**	0	**Flammability**	0	**Instability** 0	**Special hazards**	-
HMIS	**Health hazards**	0	**Flammability**	0	**Physical hazards** 0	**Personal protection**	X

Key or legend to abbreviations and acronyms used in the safety data sheet

Legend Section 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

TWA	TWA (time-weighted average)	STEL	STEL (Short Term Exposure Limit)
Ceiling	Maximum limit value	*	Skin designation

Key literature references and sources for data used to compile the SDS

Agency for Toxic Substances and Disease Registry (ATSDR)
U.S. Environmental Protection Agency ChemView Database
European Food Safety Authority (EFSA)
EPA (Environmental Protection Agency)
Acute Exposure Guideline Level(s) (AEGL(s))
U.S. Environmental Protection Agency Federal Insecticide, Fungicide, and Rodenticide Act
U.S. Environmental Protection Agency High Production Volume Chemicals
Food Research Journal
Hazardous Substance Database
International Uniform Chemical Information Database (IUCLID)
National Institute of Technology and Evaluation (NITE)
Australia National Industrial Chemicals Notification and Assessment Scheme (NICNAS)
NIOSH (National Institute for Occupational Safety and Health)
National Library of Medicine's ChemID Plus (NLM CIP)
National Library of Medicine’s PubMed database (NLM PUBMED)
National Toxicology Program (NTP)
New Zealand's Chemical Classification and Information Database (CCID)
Organization for Economic Co-operation and Development Environment, Health, and Safety Publications
Organization for Economic Co-operation and Development High Production Volume Chemicals Program
Organization for Economic Co-operation and Development Screening Information Data Set
World Health Organization

Revision date	18-Jul-2023
Revision Note	Significant changes throughout SDS. Review all sections.

Disclaimer

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.

End of Safety Data Sheet

SAFETY DATA SHEET

Revision date 18-Jul-2023 **Revision Number** 1

1. Identification

Product identifier

Product Name Bovine Gamma Globulin, 0.125 mg/ml

Other means of identification

Catalog Number(s) 9704882

Recommended use of the chemical and restrictions on use

Recommended use Laboratory chemicals

Details of the supplier of the safety data sheet

Corporate Headquarters	Manufacturer Address	Legal Entity / Contact Address
Bio-Rad Laboratories Inc. 1000 Alfred Nobel Drive Hercules, CA 94547 USA	Bio-Rad Laboratories, Life Science Group 2000 Alfred Nobel Drive Hercules, California 94547 USA	Bio-Rad Laboratories Life Science 2000 Alfred Nobel Drive Hercules, California 94547

Technical Service 1-800-424-6723
support@bio-rad.com

Emergency telephone number

24 Hour Emergency Phone Number CHEMTREC USA: 1 (800) 424-9300

2. Hazard(s) identification

Classification

This chemical is not considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200).

Hazards not otherwise classified (HNOC)
Not applicable

Label elements

Hazard statements
This chemical is not considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200).

The product contains no substances which at their given concentration, are considered to be hazardous to health.

Appearance aqueous solution **Physical state** Liquid **Odor** Odorless

Other information
Contains animal source material. (Cattle).

3. Composition/information on ingredients

Substance

Not applicable.

Mixture

The product contains no substances which at their given concentration, are considered to be hazardous to health

*The exact percentage (concentration) of composition has been withheld as a trade secret.

4. First-aid measures

Description of first aid measures

Inhalation Remove to fresh air.

Eye contact Rinse thoroughly with plenty of water for at least 15 minutes, lifting lower and upper eyelids. Consult a physician.

Skin contact Wash skin with soap and water.

Ingestion Rinse mouth.

Most important symptoms and effects, both acute and delayed

Symptoms No information available.

Indication of any immediate medical attention and special treatment needed

Note to physicians Treat symptomatically.

5. Fire-fighting measures

Suitable Extinguishing Media Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.

Specific hazards arising from the chemical No information available.

Explosion data

Sensitivity to mechanical impact None.

Sensitivity to static discharge None.

Special protective equipment and precautions for fire-fighters Firefighters should wear self-contained breathing apparatus and full firefighting turnout gear. Use personal protection equipment.

6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

Personal precautions Ensure adequate ventilation.

Methods and material for containment and cleaning up

Methods for containment Prevent further leakage or spillage if safe to do so.

Methods for cleaning up Pick up and transfer to properly labeled containers.

7. Handling and storage

Precautions for safe handling

Advice on safe handling Handle in accordance with good industrial hygiene and safety practice.

Conditions for safe storage, including any incompatibilities

Storage Conditions Store according to product and label instructions.

8. Exposure controls/personal protection

Control parameters

Exposure Limits This product, as supplied, does not contain any hazardous materials with occupational exposure limits established by the region specific regulatory bodies.

Appropriate engineering controls

Engineering controls Showers
Eyewash stations
Ventilation systems.

Individual protection measures, such as personal protective equipment

Eye/face protection No special protective equipment required.

Skin and body protection No special protective equipment required.

Respiratory protection No protective equipment is needed under normal use conditions. If exposure limits are exceeded or irritation is experienced, ventilation and evacuation may be required.

General hygiene considerations Handle in accordance with good industrial hygiene and safety practice.

9. Physical and chemical properties

Information on basic physical and chemical properties

Physical state	Liquid
Appearance	aqueous solution
Color	colorless
Odor	Odorless
Odor threshold	No information available

Property	**Values**	**Remarks • Method**
pH	6.9	
Melting point / freezing point	0 °C / 32 °F	
Boiling point / boiling range	100 °C / 212 °F	

Flash point	No data available	None known
Evaporation rate	No data available	None known
Flammability (solid, gas)	No data available	None known
Flammability Limit in Air		None known
Upper flammability or explosive limits	No data available	
Lower flammability or explosive limits	No data available	
Vapor pressure	No data available	None known
Vapor density	No data available	None known
Relative density	No data available	None known
Water solubility	Miscible in water	
Solubility(ies)	No data available	None known
Partition coefficient	No data available	None known
Autoignition temperature	No data available	None known
Decomposition temperature	No data available	None known
Kinematic viscosity	No data available	None known
Dynamic viscosity	No data available	None known

Other information

Explosive properties	No information available
Oxidizing properties	No information available
Softening point	No information available
Molecular weight	No information available
VOC content	No information available
Liquid Density	No information available
Bulk density	No information available

10. Stability and reactivity

Reactivity No information available.

Chemical stability Stable under normal conditions.

Possibility of hazardous reactions Avoid contact with metals. This product contains sodium azide. Sodium azide can react with copper, brass, lead, and solder in piping systems to form explosive compounds and toxic gases.

Conditions to avoid None known based on information supplied.

Incompatible materials Metals.

Hazardous decomposition products None known based on information supplied.

11. Toxicological information

Information on likely routes of exposure

Inhalation Specific test data for the substance or mixture is not available.

Eye contact Specific test data for the substance or mixture is not available.

Skin contact Specific test data for the substance or mixture is not available.

Ingestion Specific test data for the substance or mixture is not available.

Symptoms related to the physical, chemical and toxicological characteristics

Symptoms No information available.

Acute toxicity

Numerical measures of toxicity

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Skin corrosion/irritation	No information available.
Serious eye damage/eye irritation	No information available.
Respiratory or skin sensitization	No information available.
Germ cell mutagenicity	No information available.
Carcinogenicity	No information available.
Reproductive toxicity	No information available.
STOT - single exposure	No information available.
STOT - repeated exposure	No information available.
Aspiration hazard	No information available.
Other adverse effects	No information available.
Interactive effects	No information available.

12. Ecological information

Ecotoxicity	The environmental impact of this product has not been fully investigated.
Persistence and degradability	No information available.
Bioaccumulation	There is no data for this product.
Other adverse effects	No information available.

13. Disposal considerations

Waste treatment methods

Waste from residues/unused products	Dispose of in accordance with local regulations. Dispose of waste in accordance with environmental legislation. Flush pipes with water frequently if discarding solutions containing sodium azide into metal piping systems.

Contaminated packaging Do not reuse empty containers.

14. Transport information

DOT Not regulated

TDG Not regulated

MEX Not regulated

IATA Not regulated

IMDG Not regulated

15. Regulatory information

International Inventories Contact supplier for inventory compliance status

US Federal Regulations

SARA 313
Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA). This product does not contain any chemicals which are subject to the reporting requirements of the Act and Title 40 of the Code of Federal Regulations, Part 372.

SARA 311/312 Hazard Categories
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CWA (Clean Water Act)
This product does not contain any substances regulated as pollutants pursuant to the Clean Water Act (40 CFR 122.21 and 40 CFR 122.42).

CERCLA
This material, as supplied, does not contain any substances regulated as hazardous substances under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302) or the Superfund Amendments and Reauthorization Act (SARA) (40 CFR 355). There may be specific reporting requirements at the local, regional, or state level pertaining to releases of this material.

US State Regulations

California Proposition 65
This product does not contain any Proposition 65 chemicals.

U.S. State Right-to-Know Regulations

Chemical name	New Jersey	Massachusetts	Pennsylvania
Water 7732-18-5	-	-	X
Sodium azide 26628-22-8	X	X	X

U.S. EPA Label Information

EPA Pesticide Registration Number Not applicable

16. Other information

NFPA	**Health hazards**	0	**Flammability**	0	**Instability** 0	**Special hazards**	-
HMIS	**Health hazards**	0	**Flammability**	0	**Physical hazards** 0	**Personal protection**	X

Key or legend to abbreviations and acronyms used in the safety data sheet

Legend Section 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

TWA	TWA (time-weighted average)	STEL	STEL (Short Term Exposure Limit)
Ceiling	Maximum limit value	*	Skin designation

Key literature references and sources for data used to compile the SDS

Agency for Toxic Substances and Disease Registry (ATSDR)
U.S. Environmental Protection Agency ChemView Database
European Food Safety Authority (EFSA)
EPA (Environmental Protection Agency)
Acute Exposure Guideline Level(s) (AEGL(s))
U.S. Environmental Protection Agency Federal Insecticide, Fungicide, and Rodenticide Act
U.S. Environmental Protection Agency High Production Volume Chemicals
Food Research Journal
Hazardous Substance Database
International Uniform Chemical Information Database (IUCLID)
National Institute of Technology and Evaluation (NITE)
Australia National Industrial Chemicals Notification and Assessment Scheme (NICNAS)
NIOSH (National Institute for Occupational Safety and Health)
National Library of Medicine's ChemID Plus (NLM CIP)
National Library of Medicine’s PubMed database (NLM PUBMED)
National Toxicology Program (NTP)
New Zealand's Chemical Classification and Information Database (CCID)
Organization for Economic Co-operation and Development Environment, Health, and Safety Publications
Organization for Economic Co-operation and Development High Production Volume Chemicals Program
Organization for Economic Co-operation and Development Screening Information Data Set
World Health Organization

Revision date	18-Jul-2023
Revision Note	Significant changes throughout SDS. Review all sections.

Disclaimer

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.

End of Safety Data Sheet

SAFETY DATA SHEET

Revision date 18-Jul-2023 **Revision Number** 2.1

1. Identification

Product identifier

Product Name Quick Start Bradford Reagent, 1X

Other means of identification

Catalog Number(s) 5000205, 5000205EDU

Recommended use of the chemical and restrictions on use

Recommended use Laboratory chemicals

Details of the supplier of the safety data sheet

Corporate Headquarters	Manufacturer Address	Legal Entity / Contact Address
Bio-Rad Laboratories Inc. 1000 Alfred Nobel Drive Hercules, CA 94547 USA	Bio-Rad Laboratories, Life Science Group 2000 Alfred Nobel Drive Hercules, California 94547 USA	Bio-Rad Laboratories Life Science 2000 Alfred Nobel Drive Hercules, California 94547

Technical Service 1-800-424-6723
support@bio-rad.com

Emergency telephone number

24 Hour Emergency Phone Number CHEMTREC USA: 1 (800) 424-9300

2. Hazard(s) identification

Classification

Acute toxicity - Oral	Category 4
Skin corrosion/irritation	Category 1 Sub-category B
Serious eye damage/eye irritation	Category 1
Specific target organ toxicity (single exposure)	Category 1

Hazards not otherwise classified (HNOC)
Not applicable

Label elements

Danger

Hazard statements
Harmful if swallowed
Causes severe skin burns and eye damage
Causes damage to organs

Appearance aqueous solution **Physical state** Liquid **Odor** Alcohol

Precautionary Statements - Prevention
Wash face, hands and any exposed skin thoroughly after handling
Do not eat, drink or smoke when using this product
Wear protective gloves/protective clothing/eye protection/face protection
Do not breathe dust/fume/gas/mist/vapors/spray

Precautionary Statements - Response
Immediately call a POISON CENTER or doctor
IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
Immediately call a POISON CENTER or doctor
IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/ shower
Wash contaminated clothing before reuse
IF INHALED: Remove person to fresh air and keep comfortable for breathing
Immediately call a POISON CENTER or doctor
IF SWALLOWED: Call a POISON CENTER or doctor if you feel unwell
Rinse mouth
Do NOT induce vomiting

Precautionary Statements - Storage
Store locked up

Precautionary Statements - Disposal
Dispose of contents/container in accordance with local, regional, national, and international regulations as applicable

Unknown acute toxicity

Other information
Harmful to aquatic life.

3. Composition/information on ingredients

Substance

Not applicable.

Mixture

Chemical name	CAS No	Weight-%	Trade secret
Phosphoric acid	7664-38-2	5 - 10	*
Methanol	67-56-1	5 - 10	*

*The exact percentage (concentration) of composition has been withheld as a trade secret.

4. First-aid measures

Description of first aid measures

General advice Show this safety data sheet to the doctor in attendance. Immediate medical attention is required.

Inhalation Remove to fresh air. If breathing has stopped, give artificial respiration. Get medical attention immediately. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. If breathing is difficult, (trained personnel should) give oxygen. Delayed pulmonary edema may occur. Get immediate medical advice/attention.

Eye contact Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Keep eye wide open while rinsing. Do not rub affected area. Remove contact lenses, if present and easy to do. Continue rinsing. Get immediate medical advice/attention.

Skin contact Wash off immediately with soap and plenty of water while removing all contaminated clothes and shoes. Get immediate medical advice/attention.

Ingestion Do NOT induce vomiting. Rinse mouth. Never give anything by mouth to an unconscious person. Get immediate medical advice/attention.

Self-protection of the first aider Ensure that medical personnel are aware of the material(s) involved, take precautions to protect themselves and prevent spread of contamination. Avoid contact with skin, eyes or clothing. Avoid direct contact with skin. Use barrier to give mouth-to-mouth resuscitation. Wear personal protective clothing (see section 8).

Most important symptoms and effects, both acute and delayed

Symptoms Burning sensation.

Indication of any immediate medical attention and special treatment needed

Note to physicians Product is a corrosive material. Use of gastric lavage or emesis is contraindicated. Possible perforation of stomach or esophagus should be investigated. Do not give chemical antidotes. Asphyxia from glottal edema may occur. Marked decrease in blood pressure may occur with moist rales, frothy sputum, and high pulse pressure.

5. Fire-fighting measures

Suitable Extinguishing Media Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.

Specific hazards arising from the chemical The product causes burns of eyes, skin and mucous membranes. Thermal decomposition can lead to release of irritating gases and vapors.

Explosion data

Sensitivity to mechanical impact None.

Sensitivity to static discharge None.

Special protective equipment and precautions for fire-fighters Firefighters should wear self-contained breathing apparatus and full firefighting turnout gear. Use personal protection equipment.

6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

Personal precautions Attention! Corrosive material. Avoid contact with skin, eyes or clothing. Ensure adequate ventilation. Use personal protective equipment as required. Evacuate personnel to safe areas. Keep people away from and upwind of spill/leak.

Other information Refer to protective measures listed in Sections 7 and 8.

Methods and material for containment and cleaning up

Methods for containment Prevent further leakage or spillage if safe to do so.

Methods for cleaning up Pick up and transfer to properly labeled containers.

7. Handling and storage

Precautions for safe handling

Advice on safe handling Handle in accordance with good industrial hygiene and safety practice. Avoid contact with skin, eyes or clothing. In case of insufficient ventilation, wear suitable respiratory equipment. Handle product only in closed system or provide appropriate exhaust ventilation. Do not eat, drink or smoke when using this product. Take off contaminated clothing and wash before reuse.

Conditions for safe storage, including any incompatibilities

Storage Conditions Keep containers tightly closed in a dry, cool and well-ventilated place. Keep out of the reach of children. Protect from moisture. Store locked up. Store away from other materials. Store according to product and label instructions.

8. Exposure controls/personal protection

Control parameters

Exposure Limits

Chemical name	ACGIH TLV	OSHA PEL	NIOSH
Phosphoric acid 7664-38-2	STEL: 3 mg/m³ TWA: 1 mg/m³	TWA: 1 mg/m³ (vacated) TWA: 1 mg/m³ (vacated) STEL: 3 mg/m³	IDLH: 1000 mg/m³ TWA: 1 mg/m³ STEL: 3 mg/m³
Methanol 67-56-1	STEL: 250 ppm TWA: 200 ppm S*	TWA: 200 ppm TWA: 260 mg/m³ (vacated) TWA: 200 ppm (vacated) TWA: 260 mg/m³ (vacated) STEL: 250 ppm (vacated) STEL: 325 mg/m³ (vacated) S*	IDLH: 6000 ppm TWA: 200 ppm TWA: 260 mg/m³ STEL: 250 ppm STEL: 325 mg/m³

Biological occupational exposure limits

Chemical name	ACGIH
Methanol 67-56-1	15 mg/L - urine (Methanol) - end of shift

Appropriate engineering controls

Engineering controls Showers
Eyewash stations
Ventilation systems.

Individual protection measures, such as personal protective equipment

Eye/face protection Tight sealing safety goggles. Face protection shield.

Hand protection Wear suitable gloves. Impervious gloves.

Skin and body protection Wear suitable protective clothing. Long sleeved clothing. Chemical resistant apron.

Respiratory protection No protective equipment is needed under normal use conditions. If exposure limits are exceeded or irritation is experienced, ventilation and evacuation may be required.

General hygiene considerations Avoid contact with skin, eyes or clothing. Wear suitable gloves and eye/face protection. Do not eat, drink or smoke when using this product. Remove and wash contaminated clothing and gloves, including the inside, before re-use. Contaminated work clothing should not be allowed out of the workplace. Regular cleaning of equipment, work area and clothing is recommended. Wash hands before breaks and immediately after handling the product.

9. Physical and chemical properties

Information on basic physical and chemical properties

Physical state	Liquid
Appearance	aqueous solution
Color	light blue
Odor	Alcohol
Odor threshold	No information available

Property	**Values**	**Remarks • Method**
pH		None known
Melting point / freezing point	No data available	None known
Boiling point / boiling range	64.72 °C / 148.5 °F	
Flash point	No data available	None known
Evaporation rate	No data available	None known
Flammability (solid, gas)	No data available	None known
Flammability Limit in Air		None known
Upper flammability or explosive limits	No data available	
Lower flammability or explosive limits	No data available	
Vapor pressure	No data available	None known
Vapor density	No data available	None known
Relative density	No data available	None known
Water solubility	Miscible in water	
Solubility(ies)	No data available	None known
Partition coefficient	No data available	None known
Autoignition temperature	No data available	None known
Decomposition temperature	No data available	None known
Kinematic viscosity	No data available	None known
Dynamic viscosity	No data available	None known

Other information

Explosive properties	No information available
Oxidizing properties	No information available
Softening point	No information available
Molecular weight	No information available
VOC content	No information available
Liquid Density	No information available
Bulk density	No information available

10. Stability and reactivity

Reactivity No information available.

Chemical stability Stable under normal conditions.

Possibility of hazardous reactions None under normal processing.

Conditions to avoid Exposure to air or moisture over prolonged periods.

Incompatible materials Acids. Bases. Oxidizing agent.

Hazardous decomposition products None known based on information supplied.

11. Toxicological information

Information on likely routes of exposure

Product Information

Inhalation Specific test data for the substance or mixture is not available. Corrosive by inhalation. (based on components). Inhalation of corrosive fumes/gases may cause coughing, choking, headache, dizziness, and weakness for several hours. Pulmonary edema may occur with tightness in the chest, shortness of breath, bluish skin, decreased blood pressure, and increased heart rate. Inhaled corrosive substances can lead to a toxic edema of the lungs. Pulmonary edema can be fatal.

Eye contact Specific test data for the substance or mixture is not available. Causes serious eye damage. (based on components). Corrosive to the eyes and may cause severe damage including blindness. May cause irreversible damage to eyes.

Skin contact Specific test data for the substance or mixture is not available. Corrosive. (based on components). Causes burns.

Ingestion Specific test data for the substance or mixture is not available. Causes burns. (based on components). Ingestion causes burns of the upper digestive and respiratory tracts. May cause severe burning pain in the mouth and stomach with vomiting and diarrhea of dark blood. Blood pressure may decrease. Brownish or yellowish stains may be seen around the mouth. Swelling of the throat may cause shortness of breath and choking. May cause lung damage if swallowed. May be fatal if swallowed and enters airways.

Symptoms related to the physical, chemical and toxicological characteristics

Symptoms Redness. Burning. May cause blindness. Coughing and/ or wheezing.

Acute toxicity

Numerical measures of toxicity

The following values are calculated based on chapter 3.1 of the GHS document

ATEmix (oral)	1,800.00 mg/kg
ATEmix (dermal)	5,058.50 mg/kg
ATEmix (inhalation-dust/mist)	10.00 mg/l
ATEmix (inhalation-vapor)	834.00 mg/l

Unknown acute toxicity

Component Information

Chemical name	Oral LD50	Dermal LD50	Inhalation LC50
Phosphoric acid 7664-38-2	= 1530 mg/kg (Rat)	= 2740 mg/kg (Rabbit)	> 850 mg/m^3 (Rat) 1 h
Methanol 67-56-1	= 6200 mg/kg (Rat)	= 15840 mg/kg (Rabbit)	= 22500 ppm (Rat) 8 h

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Skin corrosion/irritation Classification based on data available for ingredients. Causes severe skin burns and eye damage.

Serious eye damage/eye irritation Classification based on data available for ingredients. Causes serious eye damage. Causes burns.

Respiratory or skin sensitization No information available.

Germ cell mutagenicity No information available.

Carcinogenicity No information available.

Reproductive toxicity No information available.

STOT - single exposure Based on the classification criteria of the Globally Harmonized System as adopted in the country or region with which this safety data sheet complies, this product has been determined to cause systemic target organ toxicity from acute exposure. (STOT SE). Causes damage to organs if swallowed.

STOT - repeated exposure No information available.

Target organ effects Respiratory system, Eyes, Skin, Central nervous system, Gastrointestinal tract (GI).

Aspiration hazard No information available.

Other adverse effects No information available.

Interactive effects No information available.

12. Ecological information

Ecotoxicity Harmful to aquatic life.

Chemical name	Algae/aquatic plants	Fish	Toxicity to microorganisms	Crustacea
Methanol 67-56-1	-	LC50: =28200mg/L (96h, Pimephales promelas) LC50: >100mg/L (96h, Pimephales promelas) LC50: 19500 - 20700mg/L (96h, Oncorhynchus mykiss) LC50: 18 - 20mL/L (96h, Oncorhynchus mykiss) LC50: 13500 - 17600mg/L (96h, Lepomis macrochirus)	-	-

Persistence and degradability No information available.

Bioaccumulation

Component Information

Chemical name	Partition coefficient
Phosphoric acid 7664-38-2	-0.9
Methanol 67-56-1	-0.77

Other adverse effects No information available.

13. Disposal considerations

Waste treatment methods

Waste from residues/unused products Dispose of in accordance with local regulations. Dispose of waste in accordance with environmental legislation.

Contaminated packaging Do not reuse empty containers.

California Hazardous Waste Status This product contains one or more substances that are listed with the State of California as a hazardous waste.

14. Transport information

DOT Not regulated

TDG Not regulated

MEX Not regulated

IATA Not regulated

IMDG Not regulated

15. Regulatory information

International Inventories Contact supplier for inventory compliance status

US Federal Regulations

SARA 313
Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA). This product contains a chemical or chemicals which are subject to the reporting requirements of the Act and Title 40 of the Code of Federal Regulations, Part 372.

Chemical name	SARA 313 - Threshold Values %
Methanol - 67-56-1	1.0

SARA 311/312 Hazard Categories
Should this product meet EPCRA 311/312 Tier reporting criteria at 40 CFR 370, refer to Section 2 of this SDS for appropriate classifications.

CWA (Clean Water Act)
This product contains the following substances which are regulated pollutants pursuant to the Clean Water Act (40 CFR 122.21 and 40 CFR 122.42).

Chemical name	CWA - Reportable Quantities	CWA - Toxic Pollutants	CWA - Priority Pollutants	CWA - Hazardous Substances
Phosphoric acid 7664-38-2	5000 lb	-	-	X

CERCLA
This material, as supplied, contains one or more substances regulated as a hazardous substance under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302).

Chemical name	Hazardous Substances RQs	Extremely Hazardous Substances RQs	Reportable Quantity (RQ)
Phosphoric acid	5000 lb	-	RQ 5000 lb final RQ

7664-38-2			RQ 2270 kg final RQ
Methanol 67-56-1	5000 lb	-	RQ 5000 lb final RQ RQ 2270 kg final RQ

US State Regulations

California Proposition 65
This product contains the following Proposition 65 chemicals:.

Chemical name	California Proposition 65
Methanol - 67-56-1	Developmental

U.S. State Right-to-Know Regulations

Chemical name	New Jersey	Massachusetts	Pennsylvania
Water 7732-18-5	-	-	X
Phosphoric acid 7664-38-2	X	X	X
Methanol 67-56-1	X	X	X

U.S. EPA Label Information

EPA Pesticide Registration Number Not applicable

16. Other information

NFPA **Health hazards** 3 **Flammability** 0 **Instability** 0 **Special hazards** -
HMIS **Health hazards** 3 * **Flammability** 0 **Physical hazards** 0 **Personal protection** X
Chronic Hazard Star Legend ** = Chronic Health Hazard*

Key or legend to abbreviations and acronyms used in the safety data sheet
Legend Section 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

TWA	TWA (time-weighted average)	STEL	STEL (Short Term Exposure Limit)
Ceiling	Maximum limit value	*	Skin designation

Key literature references and sources for data used to compile the SDS
Agency for Toxic Substances and Disease Registry (ATSDR)
U.S. Environmental Protection Agency ChemView Database
European Food Safety Authority (EFSA)
EPA (Environmental Protection Agency)
Acute Exposure Guideline Level(s) (AEGL(s))
U.S. Environmental Protection Agency Federal Insecticide, Fungicide, and Rodenticide Act
U.S. Environmental Protection Agency High Production Volume Chemicals
Food Research Journal
Hazardous Substance Database
International Uniform Chemical Information Database (IUCLID)
National Institute of Technology and Evaluation (NITE)
Australia National Industrial Chemicals Notification and Assessment Scheme (NICNAS)
NIOSH (National Institute for Occupational Safety and Health)
National Library of Medicine's ChemID Plus (NLM CIP)
National Library of Medicine’s PubMed database (NLM PUBMED)
National Toxicology Program (NTP)
New Zealand's Chemical Classification and Information Database (CCID)
Organization for Economic Co-operation and Development Environment, Health, and Safety Publications
Organization for Economic Co-operation and Development High Production Volume Chemicals Program
Organization for Economic Co-operation and Development Screening Information Data Set
World Health Organization

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Disclaimer

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.

End of Safety Data Sheet