

iGEM McMaster  
Wet Lab Waste Project Description

2025

## Introduction

Gemmy enters the lab excited to start a new day of experiments. They put on a pair of gloves, wash their glassware, grab a fresh box of micropipette tips and microcentrifuge tubes and get to work. After a challenging day in the lab, they leave without realizing they've used 8 pairs of gloves, 10 Falcon tubes, 200 pipette tips and generated 2L of liquid waste...

...and that's just Gemmy. The UN Environmental Programme ranks plastic pollution in the top 10 global environmental challenges, with a standalone scientist producing an estimated 116 kg plastics per year (Weber, 2025). Aside from single-use waste creation, the disposal of biologically hazardous waste incurs additional energy and land costs through the standard use of autoclaving steps and landfills.

We can't blame Gemmy. Single-use plastics, amongst other types of laboratory waste, are a byproduct of maintaining safety and sterility in the field of life sciences research. However, as a community, we can do better and make our contribution to creating a sustainable future.

This year, the McMaster iGEM team is taking a step towards a more green future by tracking all the laboratory waste generated for the month of August. Using this data, a comprehensive guide will be established, which aims to provide insight into how other iGEM teams can reduce their environmental footprint.

We hope that this work provides insight into the reality of waste production in life sciences research, inspiring systemic change in laboratory practices and a greater level of inquiry into environmental issues.

# McMaster iGEM Waste Tracking Project

## Disclaimer:

This year, the scope of McMaster iGEM's project does not involve genetic cloning, and works exclusively with single-stranded DNA oligos in a Containment Level 1 lab. Thus, waste tracking and reduction regimen has not been specifically developed to accommodate the handling of bacteria, and the additional biohazardous precautions in place. It is understood that for the purposes of sterility and personal safety, accumulation of waste is exacerbated when working with biologics, and that it is far more difficult to track when working in a Biosafety Cabinet. Nevertheless, environmental consciousness must be widely exercised, and we encourage other iGEM teams to develop their own waste tracking and reduction strategies for bacterial experiments.

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## Description

Throughout the month of August 2025, the McMaster iGEM team will be tracking **all of the waste** we produce in the lab. This includes gloves, pipette tips, falcon tubes, microcentrifuge tubes, PCR tubes, well plates, serological pipettes, liquid chemical waste, water waste, miscellaneous waste products, and more. Using daily and weekly waste measurements, weekly summaries will be published on the McMaster iGEM Instagram page, highlighting insights drawn from data on sustainability progress and areas for further improvement. Moreover, changes in waste production for individual protocols will be tracked as new sustainable lab strategies are implemented throughout the month.

## Project Goals

By the end of this month, we hope to shed light on the sheer amount of waste produced in a biochemical laboratory, develop accessible waste tracking protocols to encourage transparency in research, and share waste reduction strategies that we have employed along the way. We hope to carry forward the sustainable habits and environmental awareness practiced this month into future mGEM cycles, and to inspire other researchers to do the same.

Through this initiative, we challenge iGEM teams across the globe to critically evaluate the environmental footprint of lab experiments, refine protocols to improve sustainability, and share green lab practices with other iGEM teams as we strive to spearhead synthetic biology's contribution to a circular economy.

# Waste Tracking Guidelines

## Recording Waste

Here, we will provide detailed guidelines on how we have measured the various types of waste produced by the lab. The following methods are based on what has worked for our team so far, and we hope to further standardize them as different groups attempt to follow them.

When tracking waste, it is important to collect all data in an Excel or Google Sheets spreadsheet. See the following spreadsheet for an example of how we have tracked our waste for the month of August 2025.

When creating your team's waste tracking sheet, several different metrics of waste measurement may be included, such as:

- Daily, weekly, and cumulative tips waste
- Daily, weekly, and cumulative large solid waste by mass
- Daily, weekly, and cumulative large solid waste by quantity
- Individual large solid waste mass/quantity per protocol or experiment
- Daily, weekly, and cumulative liquid chemical waste by volume
- Daily, weekly, and cumulative water waste by volume
- Daily, weekly, and cumulative miscellaneous waste by total mass

\*\* Large solid waste includes gloves, Falcon Tubes, microcentrifuge tubes, serological pipettes, well plates, acrylamide or agarose gels (include volume and size), etc, measured individually or summed together.

\*\* Miscellaneous solid waste includes kim wipes, paper towels, tape, parafilm, saran wrap, etc. No need to measure the individual mass of miscellaneous solid waste, as they are often negligible.

## General Guidelines

- For solid waste, only record when an item is being discarded to avoid double-counting.
- Be sure to update the waste tracker spreadsheet after every lab day, and program summarized totals for every week and/or month.
- For waste products that are measured as running totals in a container, be sure to program the spreadsheet to subtract the initial weight of the container from each imputed total.

## Large Solid Waste

- For large solid waste items, include a materials table at the beginning of each protocol or lab notebook entry to track individual items. Use tick marks as an easy way to count discarded consumables.



## iGEM McMaster Wet Lab Waste Project Description

- Weigh one of each type of large solid waste. Record in the waste tracker spreadsheet, and program it to calculate total mass from quantity per day/week/experiment.
- Do not discard large solid waste into the designated miscellaneous solid waste bag, as it has already been accounted for.

### Miscellaneous Solid Waste

- Obtain a biohazardous waste bag to designate as the miscellaneous solid waste bag. Only discard small waste items into this bag; do not discard large solid waste items here, as they have already been accounted for.
- Measure the weight of the plastic bag, and record it on the exterior using a Sharpie marker
- After each lab day/week, measure the total weight of the misc. waste bag, as well as the date. Record on the bag exterior and in the waste tracker spreadsheet.

### Pipette Tips

- Obtain a plastic container to designate as tip waste.
- Measure the initial container volume and record on the exterior.
- Measure and average the weight of each type of pipette tip. Alternatively, keep a different tip waste container for each size of tip for more precise measurements.
- Only discard tips into the designated tip waste container.
- At the end of each day, weigh the container and record the weight and date its exterior.
- Input the measurements into the waste tracker spreadsheet, and be sure to program the sheet to calculate quantity using the average/precise mass of one tip.

### Water Waste

- Note that water involved in handwashing is not included in water waste measurements, as we do not want to encourage the reduction in handwashing as a strategy to reduce water consumption.
- Obtain a large plastic basin and place it in the sink, under the faucet. This basin will be designated as the waste water collector.
- Be sure to wash all glassware over this plastic basin to collect waste water.
- Obtain a large plastic beaker or graduated cylinder to measure total water waste.
- Optionally, during the first round waste collection, periodically pour the waste water accumulated in the basin into the beaker or graduated cylinder to measure approximate volumes. Make markings on the side of the basin with the respective measured volume as a proxy for future measurements.
- Alternatively, measure and record waste water accumulation in the beaker or graduated cylinder after each lab day.



## Liquid Chemical Waste

- Reserve a plastic waste container for your project's chemical waste.
  - If necessary, reserve multiple waste containers for chemicals that are incompatible.
- Record the initial container weight.
- Be sure to label chemical waste components on the outside of each container, and include any safety handling guidelines according to the SDSs.
- Weigh the liquid chemical waste container after each week, and program the spreadsheet to convert to liters using the density of water.
  - Error is introduced when making the assumption that all liquid chemical waste has the density of water

**Ultimately, waste tracking data is underestimated due to various assumptions made in the tracking progress, and inevitable human error. Despite this, tracking lab waste is essential for increasing the transparency of lab practices that are often hidden to the public. Reporting these numbers is an essential starting point for initiating large-scale efforts to reduce lab waste.**

## Sustainable Lab Practices

### General Considerations for Increasing Environmental Sustainability in Lab

- Which protocols and/or experiments produce the most waste?
- How can lab days and workflows be planned to limit needless discarding of plastic materials?
- What plastic consumables can be reused within an experiment without sacrificing its sterility?
- Where can plastic consumables be supplemented with glass containers? Be mindful of enzymes, which adhere to glass surfaces.

### Strategies Currently Implemented

- **Plan ahead.**
  - For each protocol, the total number of microcentrifuge tubes is often summarized so that tubes are not needlessly discarded.
  - If a liquid reagent is being measured several independent times during a protocol the first serological pipette used will be labeled and saved for the subsequent measurements.
- Save gloves when possible, especially if they have not come into contact with any biohazardous reagents.
- Label and save serological pipettes that are often used to measure buffers, water, etc. Only do so if sterility is not a major concern, such as when measuring running buffers for gel electrophoresis.
  - This is commonly done for 1X TBE, binding buffers, and UltraPure Water.
- Avoid serological pipettes when possible by using graduated cylinders, or markings on the side of Falcon Tubes or beakers when precision is not a major concern.
- 96-well plates and 384-well plates are preserved for further use if many wells are unused.
- When washing glass plates and apparatuses for denaturing PAGE, DI water and SparkKleen detergent is saved in the waste water basin, and is used to wash other glass plates.
- Tips are not discarded between loading of triplicates, or between serial dilutions.
- Utilize Master Mixes when building reactions in plates to reduce the amount of pipette tips used and loading error

**As passionate students of science and sustainability, every small effort to reduce waste matters.**

## Information Accessibility

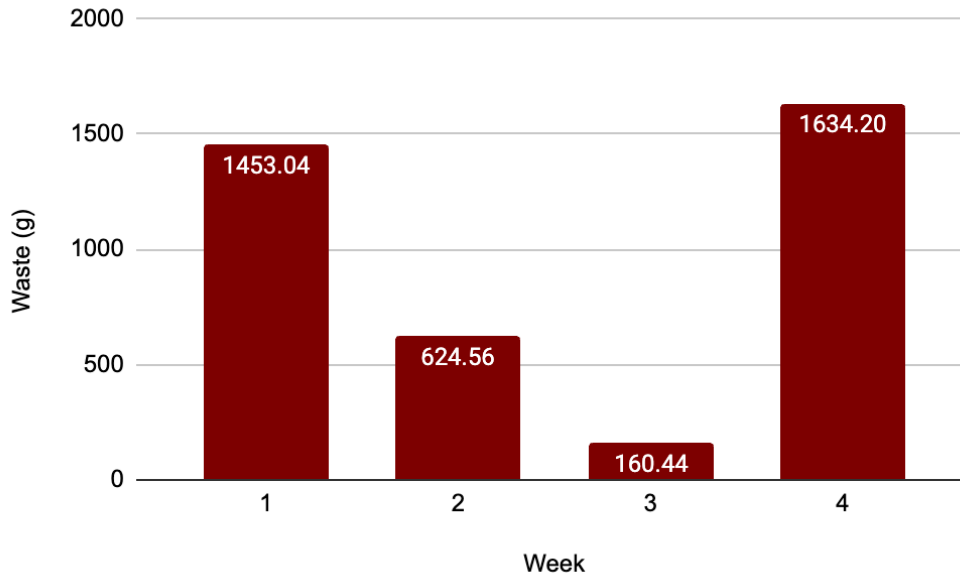
### McMaster iGEM Instagram

See the McMaster iGEM Instagram page below for our weekly updates during the month of August 2025!

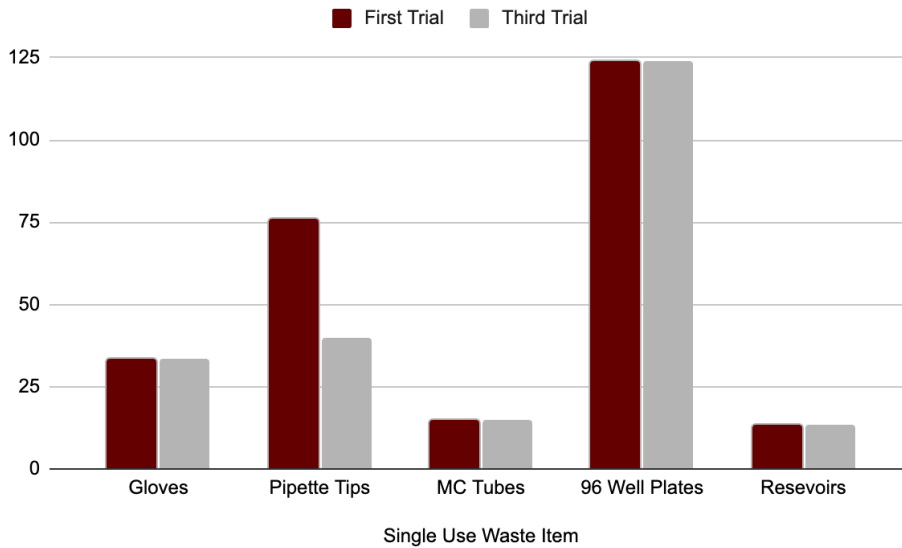
[https://www.instagram.com/igemmcmaster?utm\\_source=ig\\_web\\_button\\_share\\_sheet&igsh=cWtheWxkc2lzYmF5](https://www.instagram.com/igemmcmaster?utm_source=ig_web_button_share_sheet&igsh=cWtheWxkc2lzYmF5)

## Results

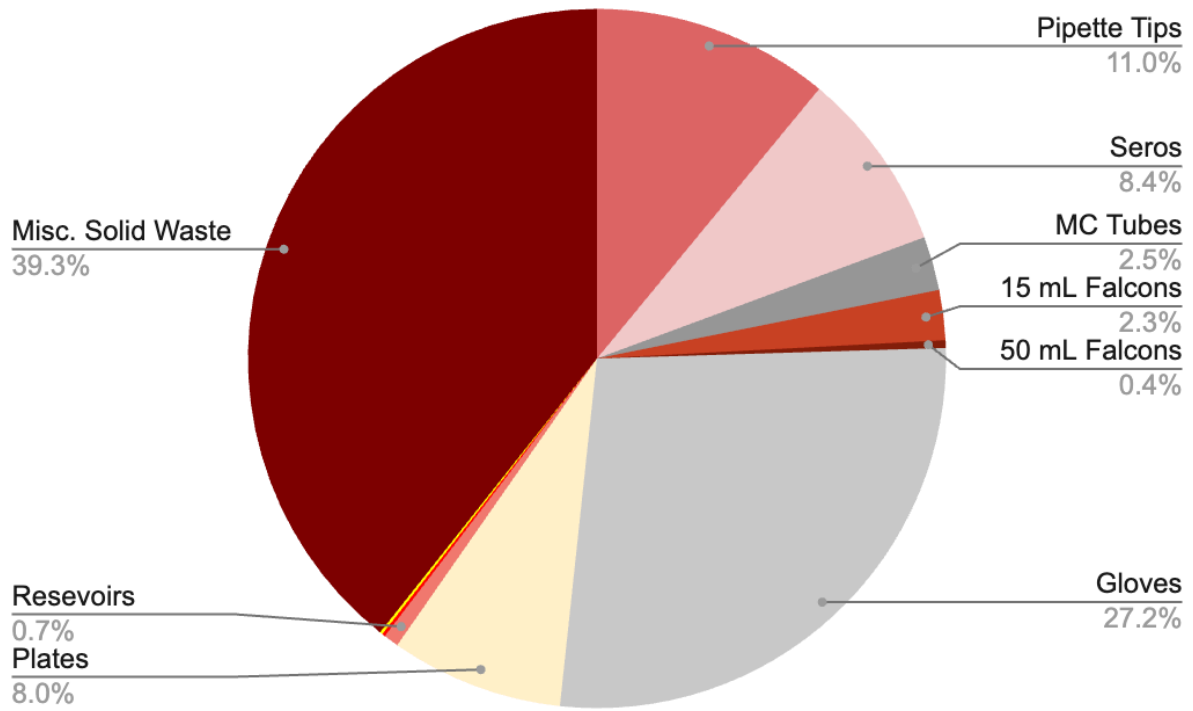
### Solid Waste Output per Week



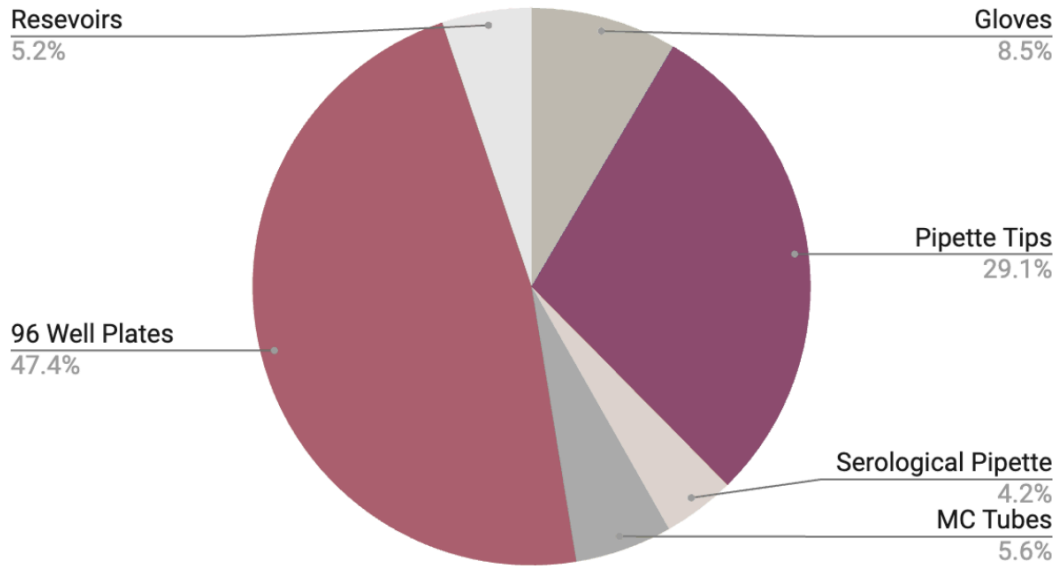
### Change in Mass of Waste Produced: First vs. Most Recent Trial



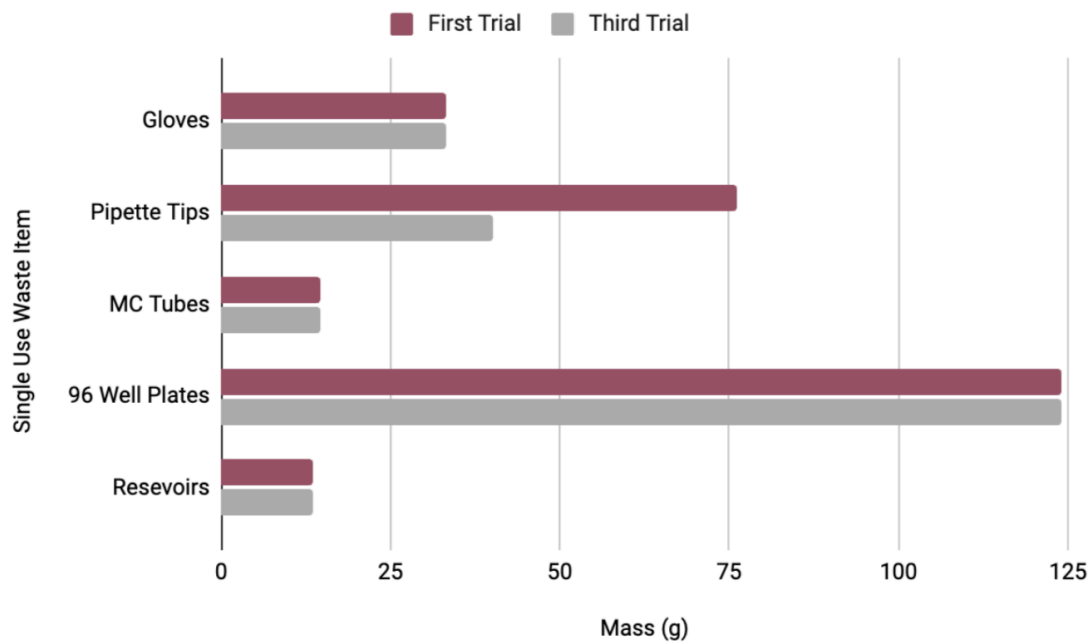
## Share of Solid Waste Categorized by Type



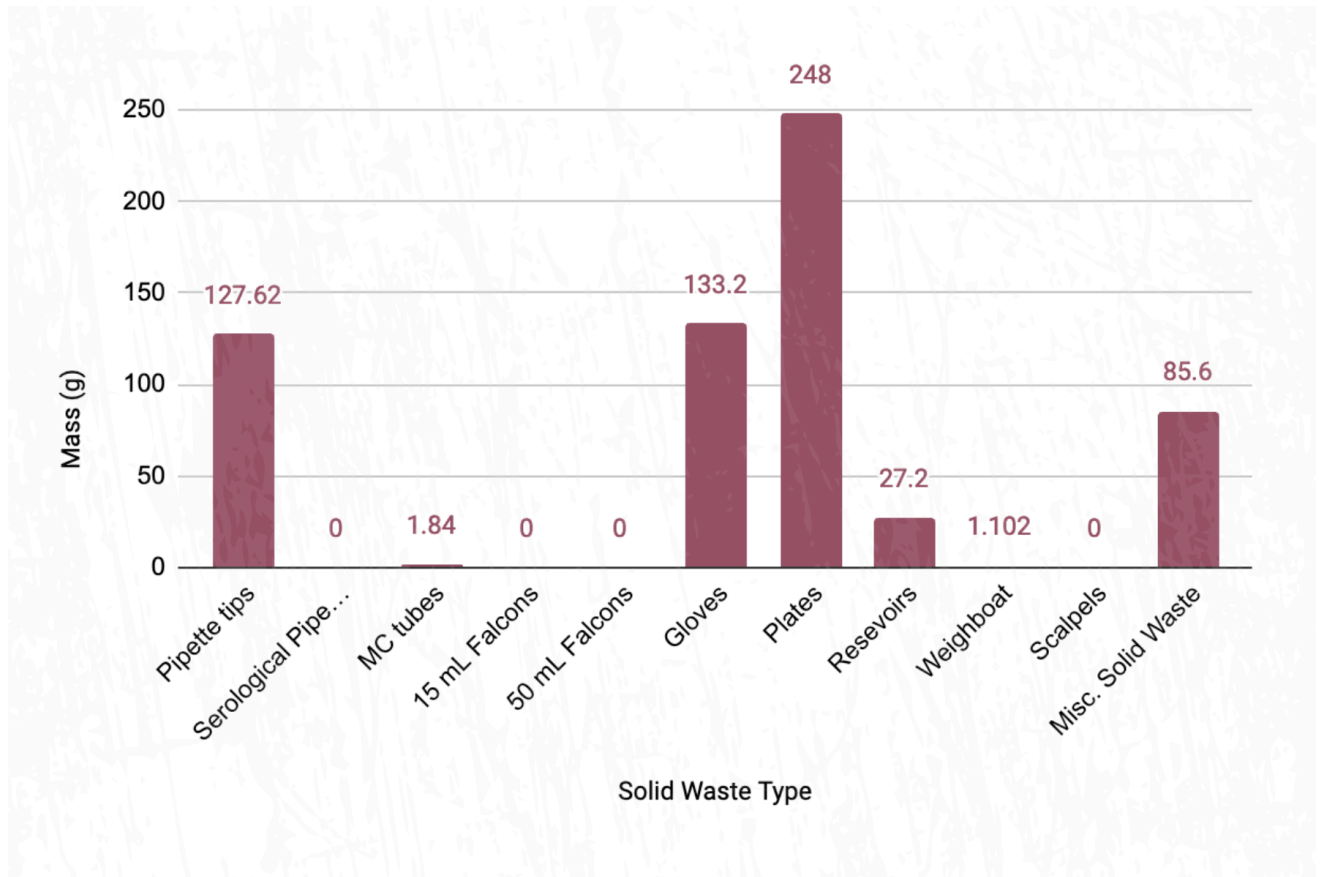
## Week 2: Share of Single-use Waste by Mass



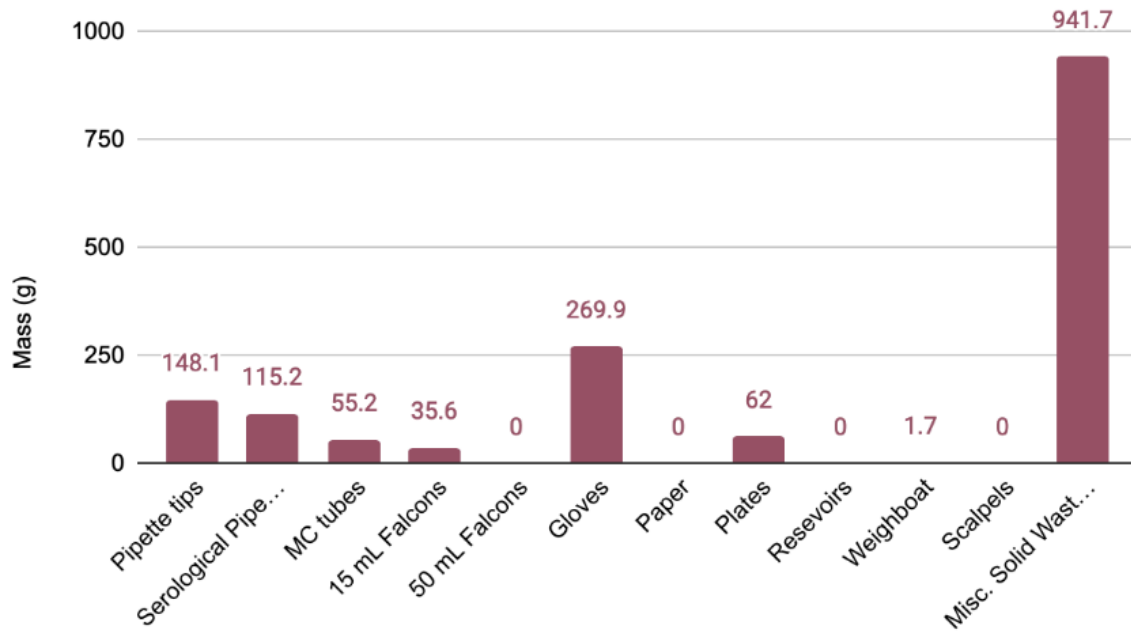
## Week 2: Change in Waste Generation (First vs. Most Recent Trial)



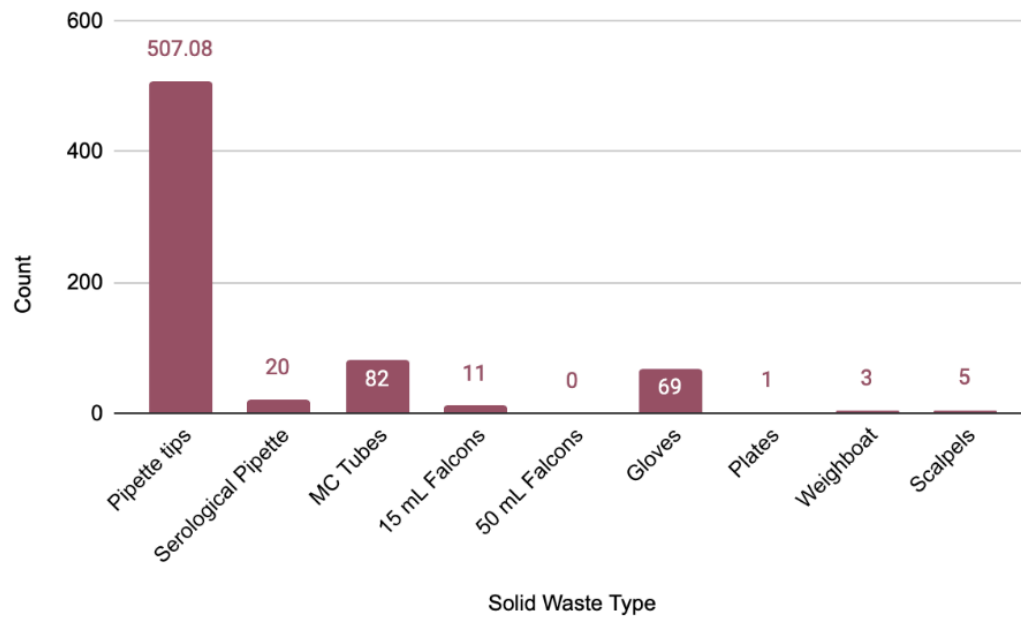
## Week 2: Mass of Solid Waste Produced by Type



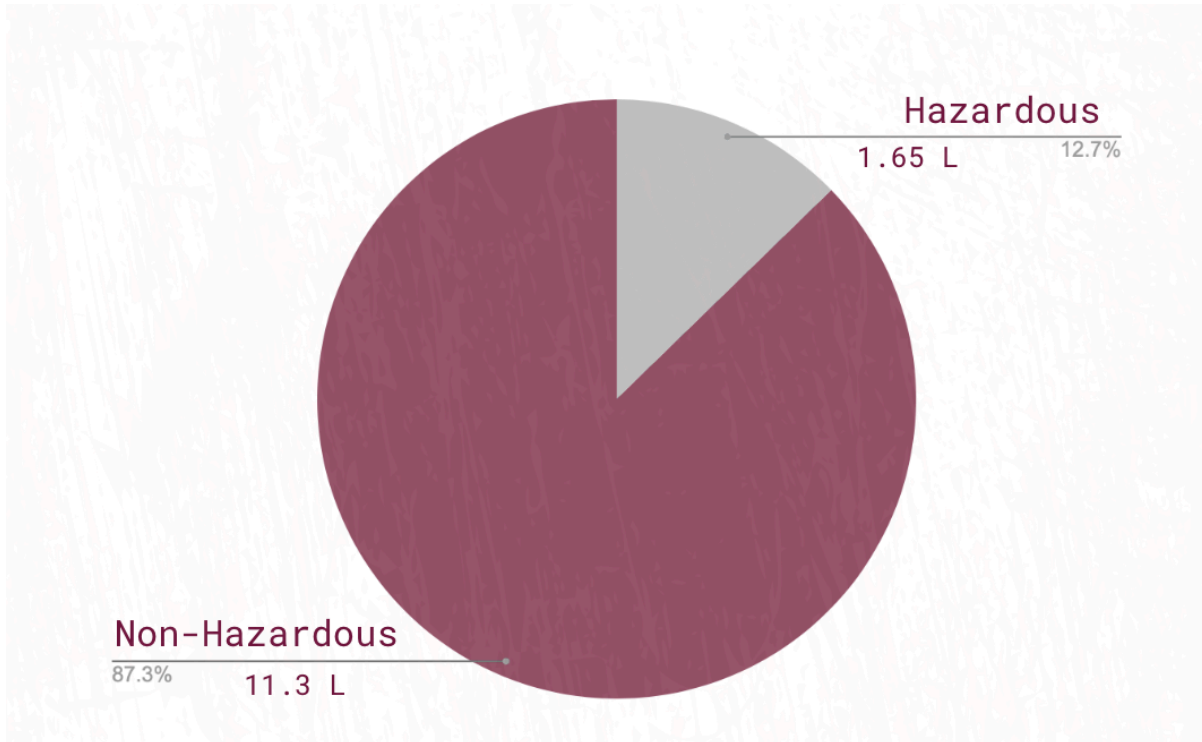
## Weeks 3 & 4: Share of Single-Use Waste by Mass



## Weeks 3 & 4: Count of Solid Waste Items



### Weeks 3 & 4: Volume of Liquid Waste Produced by Type





# END OF MONTH REFLECTION

## Questions to Answer

- What have been our biggest takeaways from this project?
- How can we improve measurement strategies to increase replicability/standardization across iGEM teams?.

I felt the waste tracking project was a great way to bring environmental consciousness to the forefront while planning and performing experiments. We'd find ourselves writing a protocol and realize we could reduce the amount of pipette tips or tubes we used by bringing in tools like multichannel pipettes or rethinking experimental workflows by utilizing master mixes. What I found especially interesting, though, is that by thinking of reducing waste, we often also reduce the room for error in our experiments. Multichannel pipettes reduced our pipetting errors while cutting our tip waste in half, and master mixes made experiments run smoother and faster, thereby reducing human error. If we're to repeat this project, I would build in waste tracking sections into the physical protocols themselves, rather than relying on notetaking methods which are very error-prone. Perhaps by integrating this system, we would also gain insight into our inventory management and the financial burden on our supervising lab.

- Kevin

## References

Weber, P. M., Michelsen, C., & Kerou, M. (2025). What's in our bin? EMBO Reports.

<https://doi.org/10.1038/s44319-024-00360-x>