Using Lyophilization To Create Reagent Pellets for Rapid Covid 19 Testing

Kayla Karl

High School Chemistry
Basis Primary School
Mentors: Jennifer Blain Christen, Ryan Flores, Michael Hansen

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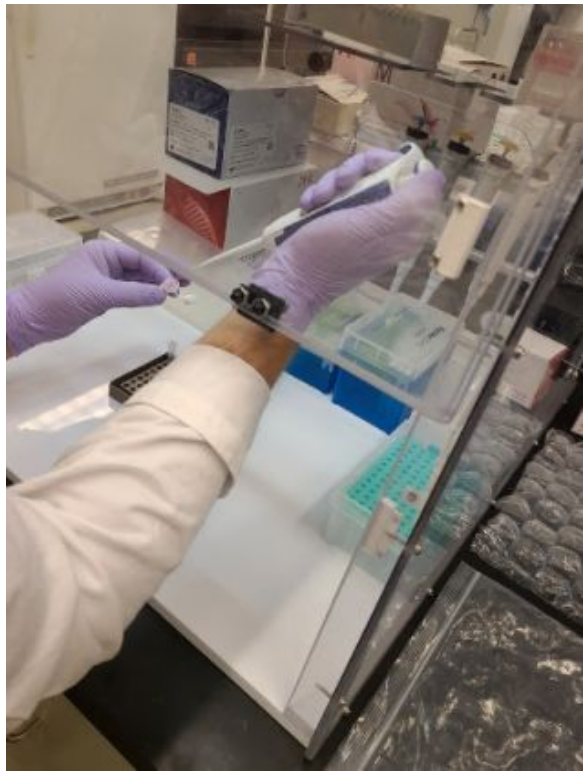
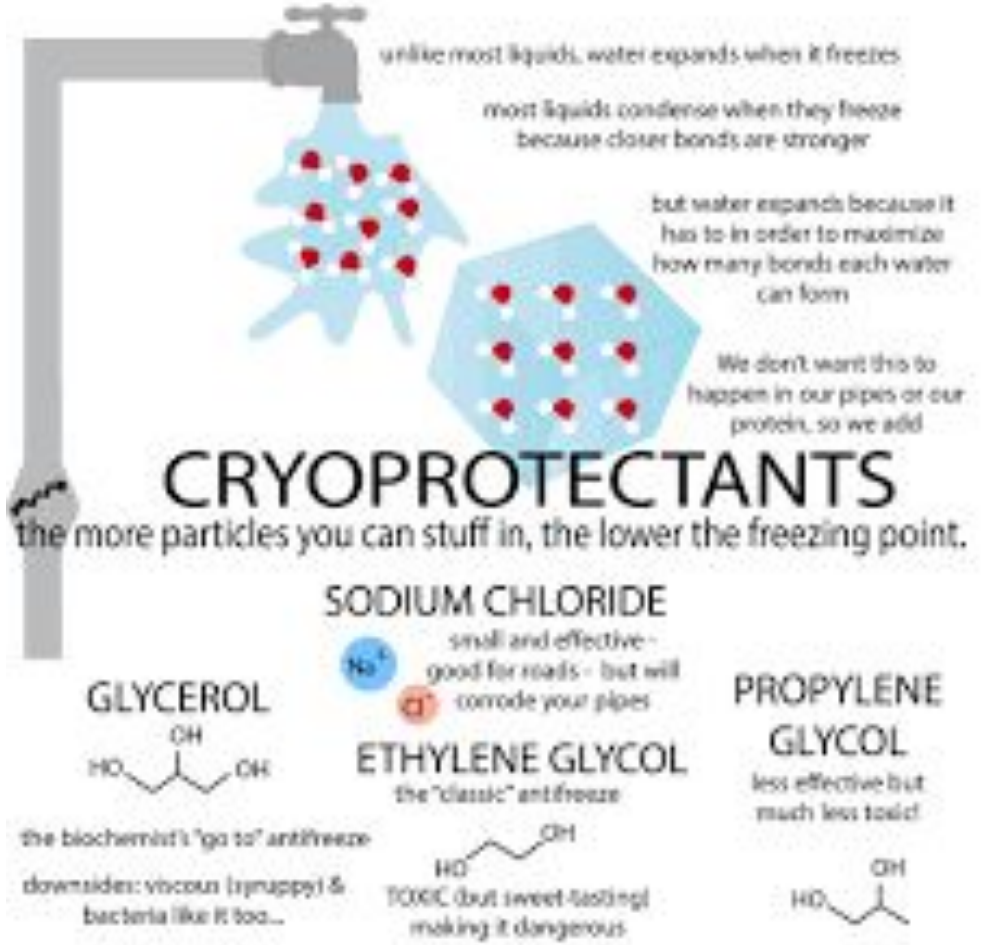


RET Research and Training

RET Schedule and Training

Hands On Technical Training

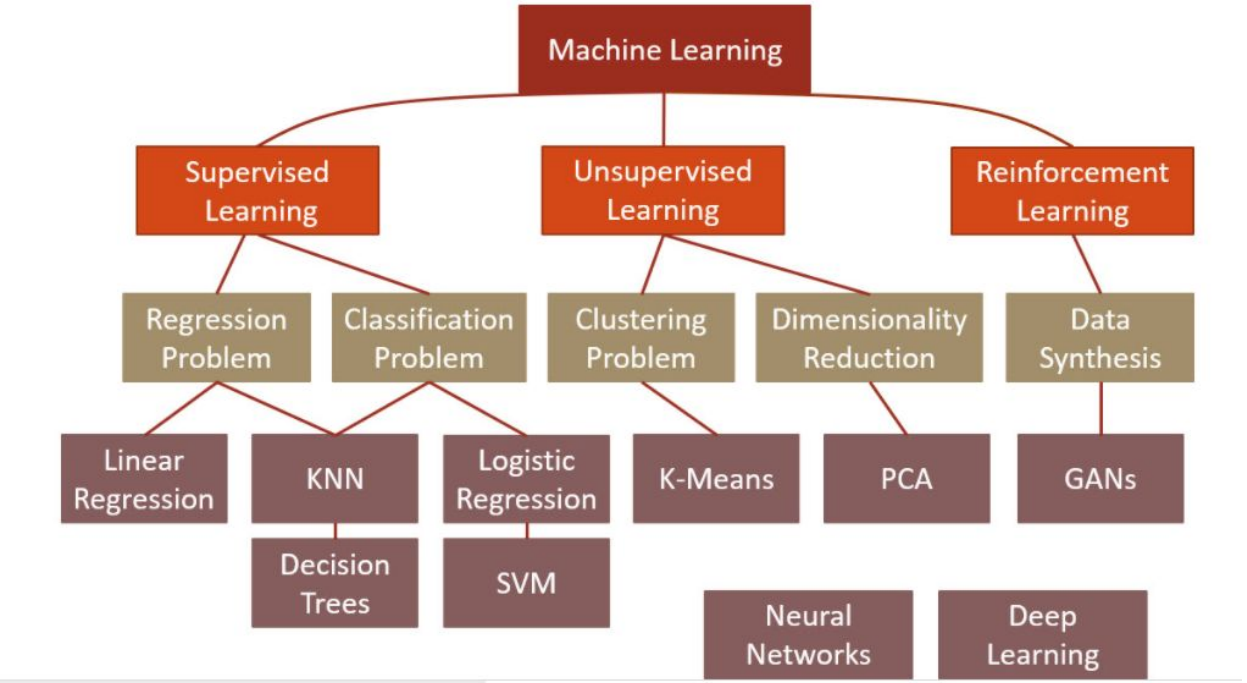
- Canvas: Machine learning videos, sensor videos, sample work, training
- Explored: machine learning with cat and dog dataset
- Researched: Reagents, lyophilization, PoCT devices, cryoprotectants



RET Schedule and Training

Technical Exposition

- Kristen Jaskie- ML algorithms
  - Clustering and K-means
  - Regression and prediction
  - Classification
  - Neural networks
- Mike Stanley- Intro to ML
  - Embedded machine learning
  - Embedded Hardware
  - Software development



RET Lab Experience Research Summary

Research Objectives

- Create a rapid PoCT device that test for Covid-19 in saliva to send to developing countries. We plan to lyophilize reagents that are viable and able to withstand uncertain temperatures then place them into a PoCT device that is user friendly.

RET Lab Experience Research Summary

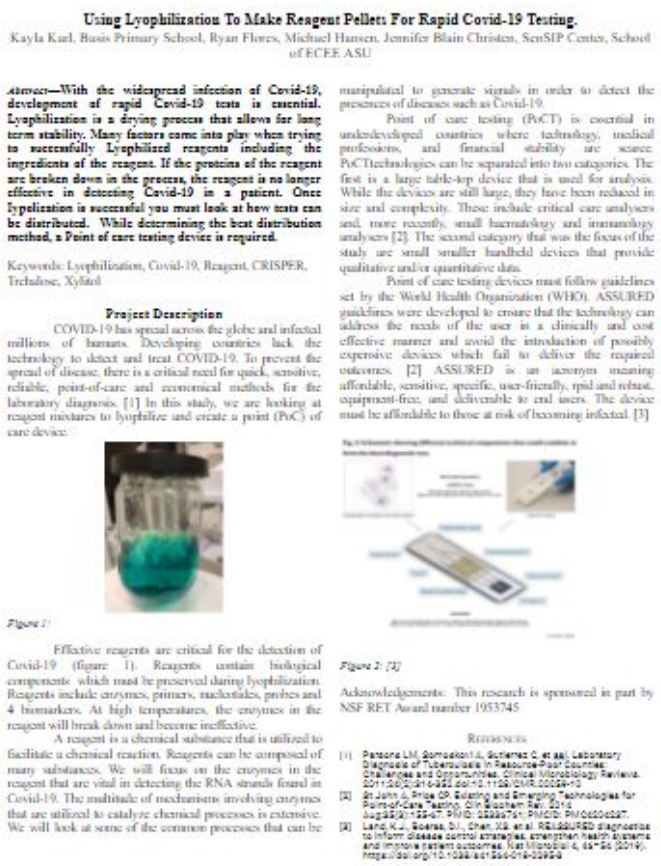
Research Background

- In order to create a reagent that is viable after lyophilization, we must research cryoprotectants to ensure that the proteins are not being denatured during the lyophilization process.
- Similar work has been done to determine a PoCT device that adheres to the WHO guidelines. We plan to utilize that information to create a PoCT device.

RET Lab Experience Research Summary

Research Proposal

Abstract—With the widespread infection of Covid-19, development of rapid Covid-19 tests is essential. Lyophilization is a drying process that allows for long term stability. Many factors come into play when trying to successfully Lyophilized reagents including the ingredients of the reagent. If the proteins of the reagent are broken down in the process, the reagent is no longer effective in detecting Covid-19 in a patient. Once lypolization is successful you must look at how tests can be distributed. While determining the best distribution method, a Point of care testing device is required.



Using Lyophilization To Make Reagent Pellets For Rapid Covid-19 Testing.

Kayla Karl, Basis Primary School, Ryan Flores, Michael Hansen, Jennifer Blain Christen, SenSIP Center, School of ECEE ASU

***Abstract*—With the widespread infection of Covid-19, development of rapid Covid-19 tests is essential. Lyophilization is a drying process that allows for long term stability. Many factors come into play when trying to successfully Lyophilized reagents including the ingredients of the reagent. If the proteins of the reagent are broken down in the process, the reagent is no longer effective in detecting Covid-19 in a patient. Once lypolization is successful you must look at how tests can be distributed. While determining the best distribution method, a Point of care testing device is required.**

Keywords: Lyophilization, Covid-19, Reagent, CRISPER, Trehalose, Xylitol

Project Description

COVID-19 has spread across the globe and infected millions of humans. Developing countries lack the technology to detect and treat COVID-19. To prevent the spread of disease, there is a critical need for quick, sensitive, reliable, point-of-care and economical methods for the laboratory diagnosis. [1] In this study, we are looking at reagent mixtures to lyophilize and create a point (PoC) of care device.

Figure 1:

Effective reagents are critical for the detection of Covid-19 (figure 1). Reagents contain biological components which must be preserved during lyophilization. Reagents include enzymes, primers, nucleotides, probes and 4 biomarkers. At high temperatures, the enzymes in the reagent will break down and become ineffective.

A reagent is a chemical substance that is utilized to facilitate a chemical reaction. Reagents can be composed of many substances. We will focus on the enzymes in the reagent that are vital in detecting the RNA strands found in Covid-19. The multitude of mechanisms involving enzymes that are utilized to catalyze chemical processes is extensive. We will look at some of the common processes that can be manipulated to generate signals in order to detect the presences of diseases such as Covid-19.

Point of care testing (PoCT) is essential in underdeveloped countries where technology, medical professions, and financial stability are scarce. PoCTechnologies can be separated into two categories. The first is a large table-top device that is used for analysis. While the devices are still large, they have been reduced in size and complexity. These include critical care analysers and, more recently, small haematology and immunology analysers [2]. The second category that was the focus of the study are small smaller handheld devices that provide qualitative and/or quantitative data.

Point of care testing devices must follow guidelines set by the World Health Organization (WHO). ASSURED guidelines were developed to ensure that the technology can address the needs of the user in a clinically and cost effective manner and avoid the introduction of possibly expensive devices which fail to deliver the required outcomes. [2] ASSURED is an acronym meaning affordable, sensitive, specific, user-friendly, rpid and robust, equipment-free, and deliverable to end users. The device must be affordable to those at risk of becoming infected. [3]

Figure 2: [2]

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References

[1] Parsons LM, Somoskovi A, Gutierrez C, et al. Laboratory Diagnosis of Tuberculosis in Resource-Poor Countries: Challenges and Opportunities. Clinical Microbiology Reviews. 2011;24(2):314-350. doi:10.1128/CMR.00059-10

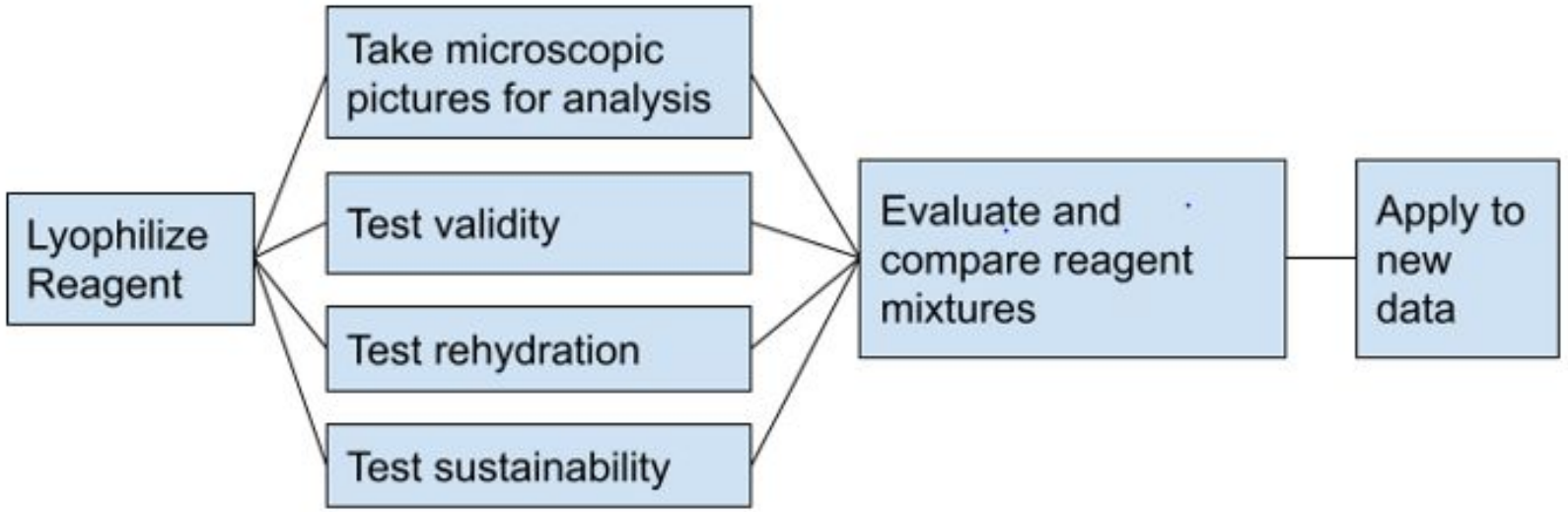
[2] St John A, Price CP. Existing and Emerging Technologies for Point-of-Care Testing. Clin Biochem Rev. 2014 Aug;35(3):155-67. PMID: 25298751; PMCID: PMC4204237.

[3] Land KJ, Boeras DI, Chen XS, et al. REASSURED diagnostics to inform disease control strategies, strengthen health systems and improve patient outcomes. Nat Microbiol 4, 46–54 (2019). https://doi.org/10.1038/s41564-018-0295-3

RET Lab Experience Research Summary

Research Conclusions

No conclusion yet… Continue research on cryoprotectants, lyophilization temperatures, and device structure



Next STEPS in Research

- Continue with machine learning to bring into the classroom.
- Finalize IEEE report
- Implement the lesson I created with my students and publish it in Teach Engineering
- Finalize my poster project with my classroom implementation.

RET Instructional Lesson Implementation

Lesson Objectives

- Students explore problem solving techniques by researching, analyzing, and evaluating the pH of water through the manufacturing of pH pellets.
- During the activity, students research the importance of pH in consumable water. After reviewing how to use ImageJ to analyze data, students create their controlled pH pellet.
- Students develop two different formulas along with a controlled formula to create the most sustainable, inexpensive, and accurate pH pellet.
  - With the chosen formula, students create different size pellets. Students utilize ImageJ to determine the average size of the pellet with the most cost efficiency, accuracy and sustainability.
  - Students present their data in the form of a poster project.

RET Instructional Lesson Implementation

Lesson Description

- This is in inquiry based lab where students are able to explore, draw conclusions, and obtain data.
- NGSS Standards
  - HS-PS1-5.
    - Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.
  - HS-LS2-.1
    - Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.
  - HS-ESS3-3
    - Create a computational simulation to illustrate the relationships among the management of natural resources, the sustainability of human populations, and biodiversity.

Questions & Feedback

- What's one thing you liked about the lesson and one thing you think I should still be thinking about?

Self Assessment

The best parts...

- Hands-on learning in the laboratory.
- Researching a topic that is relevant at the moment
- Creating a lesson that my students will love and remember

Challenges

- It was hard to join the meetings during the day and a lot of work to catch up on what I missed when doing the laboratory research.
- Writing IEEE report without a deep understanding of the topic

References

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