Building Undergraduate Research Capacity at a 2-Year HSI

Dr. Saroj Chirravuri
Dr. Jennifer Foltz-Sweat
GateWay Community College

Overview

- ❑ STEM Education in Community Colleges
- ❑ CURES as a High Impact Practice
- ❑ CUREs and the GateWay Mission
- ❑ Challenges
- ❑ Addressing the Obstacles
- ❑ Professional Growth

Opportunity gaps between overrepresented and underrepresented students have been called “one of the most urgent and intractable problems in higher education.”

Bensimon 2005, cited in Theobald et al 2020

STEM Education in Community Colleges

2021 data compiled by the National Science Board indicate that the percentage of minority employees in the STEM workforce is below that of the total workforce.

Distribution of select racial and ethnic groups in the workforce, by occupational group: 2021

(Percent)

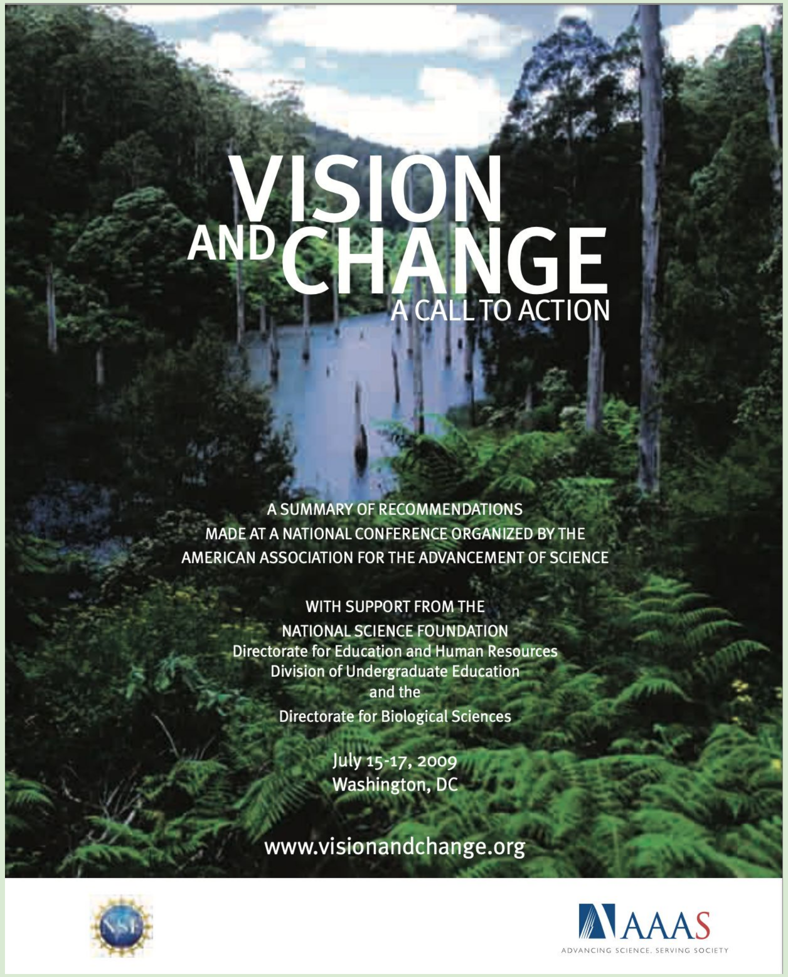
Occupation group	White	Hispanic or Latino	Black or African American	Asian	American Indian or Alaska Native	Some other race or more than one race
All workers	59.8	18.2	11.0	6.3	0.4	4.3
STEM	62.9	14.8	8.2	9.5	0.3	4.3
S&E	60.9	9.5	6.8	18.0	0.2	4.6
S&E-related	65.3	10.6	9.6	9.9	0.3	4.3
Middle-skill	62.0	22.5	7.7	3.4	0.5	4.0
Non-STEM	58.8	19.3	11.9	5.2	0.4	4.4

Note(s):
STEM is science, technology, engineering, and mathematics. Hispanic or Latino may be any race; race categories exclude Hispanic origin.

Source(s):
Census Bureau, ACS, 2021.

Indicators 2024: Labor Force

STEM Education in Community Colleges



NSF-sponsored initiative to increase representation in STEM.

STEM Education in Community Colleges

Community colleges play a vital role in national efforts to diversify our STEM workforce.

The more than 1000 community colleges in the U.S. educate a diverse student body consisting of:

- ❑ 46% students within the lowest income quartile
- ❑ 29% first-generation
- ❑ 15% single parents
- ❑ 20% students with disabilities
- ❑ 4% veterans

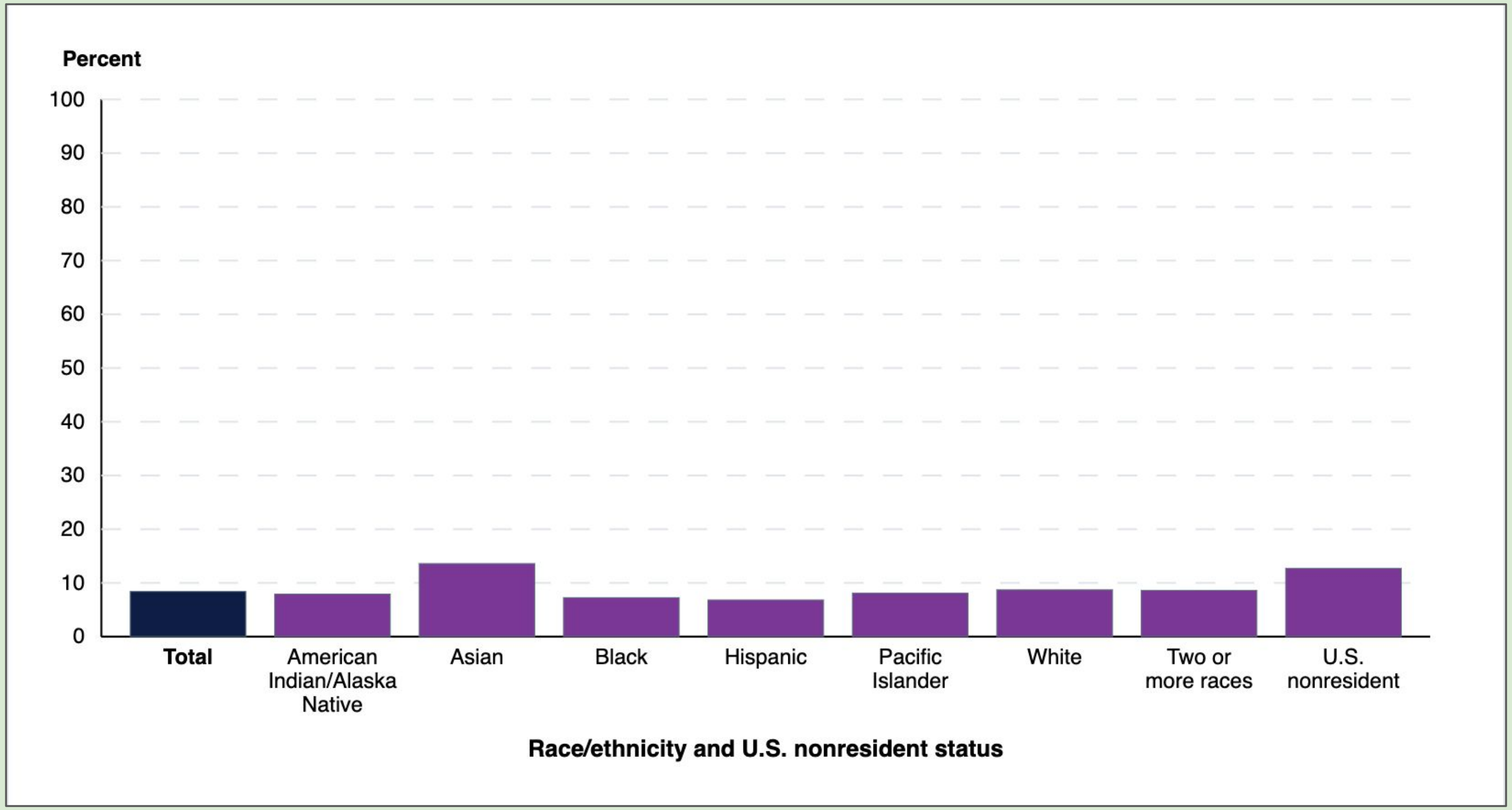
AACC. (2022). Fast facts. Retrieved July 4, 2022, from www.aacc.nche.edu/research-trends/fast-facts

STEM Education and Equity

From 2018-2019, CCs in the U.S. awarded 1M associate's degrees.

18.3% were in health professions & related programs

Leonetti et al. 2023



Percentage of associate's degrees conferred by degree-granting postsecondary institutions in science, technology, engineering, and mathematics (STEM) fields, by race/ethnicity and U.S. nonresident status: Academic year 2021–22. US Department of Education, National Center for Education Statistics

STEM Education in Community Colleges

Why are students of color underrepresented in STEM?

Many students who begin college as STEM majors switch to other fields before graduating.

- 42% of white students
- 58% of Latino students
- 66% of Black students

Although lecturing is the standard teaching method for many introductory STEM classrooms, it is less effective than active learning.

Handelsman et al. 2022.
https://www.science.org/doi/10.1126/science.abn9515

“Players at every level of higher education have the power to contribute to needed changes.”

~Achieving STEM diversity: Fix the classrooms. Handelsman et al. 2022.

CUREs as a High Impact Practice

High-impact practices are tools educators can employ strategically to link diverse and often disjointed elements of the collegiate experience.

- Service learning
- Internships
- Learning communities
- Capstone projects
- Collaborative assignments
- Undergraduate research

CUREs as a High Impact Practice

STEM-training pathways should develop content knowledge, but they must also focus on ***collaboration*** and ***communication*** skills.

Healthcare students must develop the ability to translate and apply knowledge acquired through scientific research to address emerging public health crises.

U.S. Department of Health and Human Services

Enhancing the health and well-being of all Americans

CUREs as a High Impact Practice

Actions to create inclusive STEM college classrooms

PRINCIPLE	EXAMPLES	NATIONAL INITIATIVES	ACADEMIC LEADERSHIP	INSTRUCTORS
Overall actions		Funding agencies and institutional rating services require evidence of STEM inclusivity.	Advocate for inclusive classroom practices.	Adopt inclusive classroom practices.
Reform teaching practices	Active learning in lecture courses	Federal and private funding agencies support workshops and communities of practice to expand instructor training.	Provide funding and time to train instructors in evidence-based teaching.	Acquire training in evidence-based teaching.
	Research courses (CUREs) for first-year students	Federal and private agencies support national projects and local initiatives to enable instructors to teach CUREs.	Provide funding to promote CUREs to potential donors, lawmakers, and local community partners.	Teach existing CUREs or develop new ones.
Create welcoming classrooms	Values affirmation, growth mindset, discussion of adversity	Require evidence of institutional practices that increase persistence of underrepresented students for eligibility for federal funding and require bias training for investigators on all grants.	Include adoption of inclusive classroom practices in evaluation for tenure, promotion, and teaching awards; incentivize instructor communities of practice for inclusive approaches.	Integrate welcoming-classroom practices into syllabus and classroom.
Expand relevance to diverse groups	Social impact of STEM and incorporation of diverse role models	Federal agencies, advertisers, and national publications spotlight diverse STEM professionals and the impact of STEM on diverse societal issues.	Spotlight diverse STEM faculty and the impact of STEM discoveries on diverse societal issues.	Include impacts of STEM on society and diverse role models in course content and public art.

Handelsman et al. 2022 https://www.science.org/doi/10.1126/science.abn9515

CUREs as a High Impact Practice

Educational experience in which students engage in research within the parameters of a course.

Hallmarks of a CURE

- ✔ Authenticity
- ✔ Iteration
- ✔ Ownership
- ✔ Relevance
- ✔ Discovery
- ✔ Dissemination

What is a CURE?

Course-based
Undergraduate
Research
Experience

CUREs increase:

- ➢ STEM confidence
- ➢ Research skills
- ➢ Project ownership
- ➢ Retention in STEM
- ➢ Self-efficacy
- ➢ Belonging

CUREs and the GWCC Mission

The mission statement of GateWay Community College is to provide inclusive, equitable, and meaningful learning opportunities that prepare students to thrive in a global community

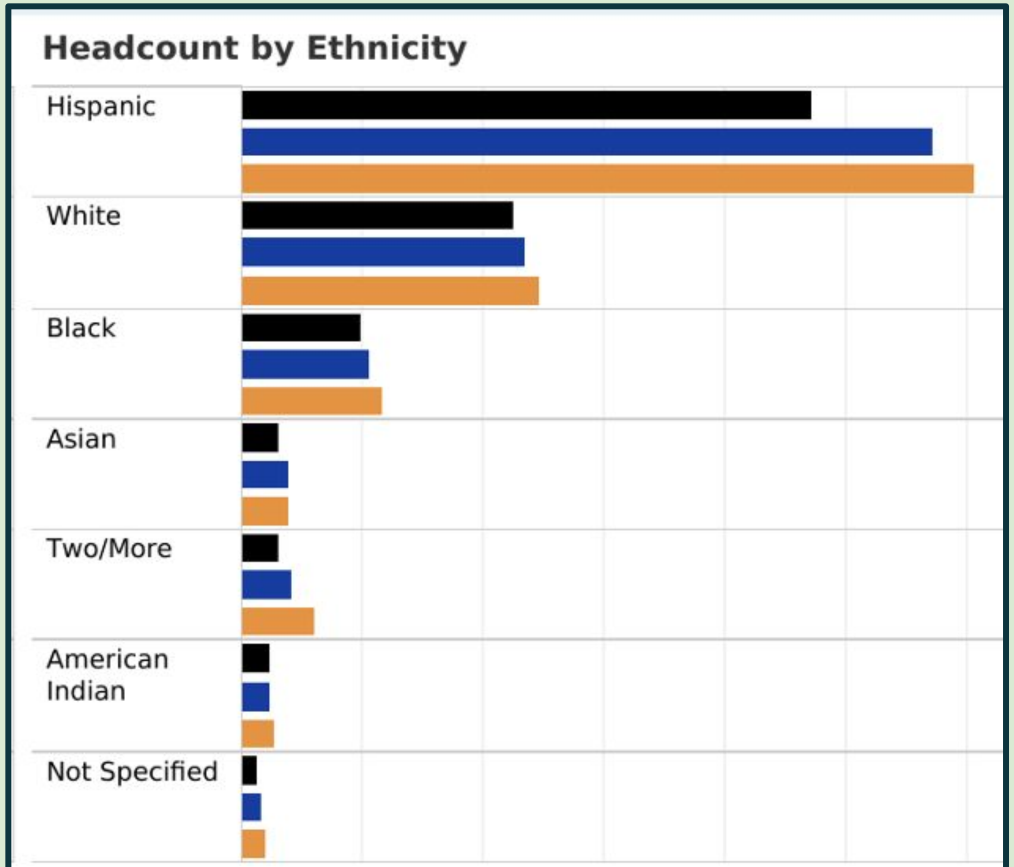
Institution Level Outcomes (ILOs)

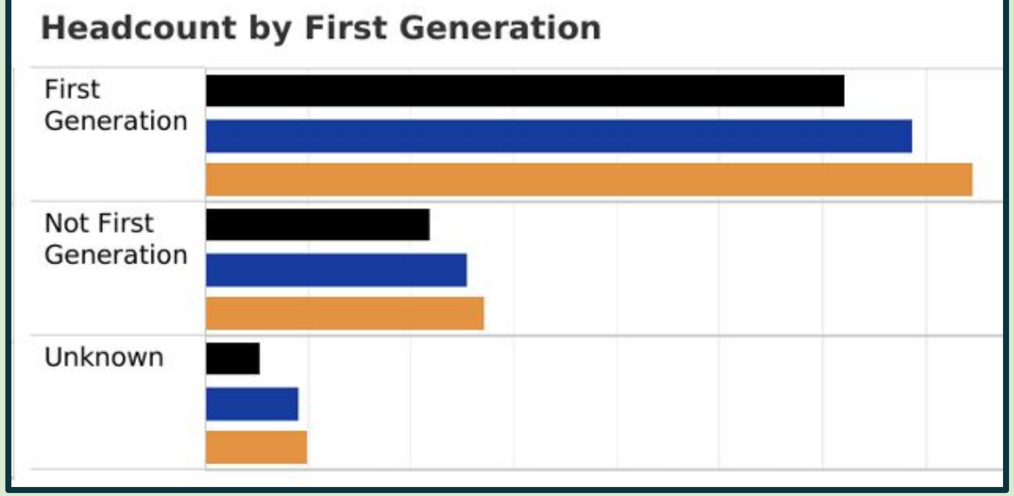
1) Effective Communication
2) Critical Thinking and Problem Solving
3) Personal Responsibility and Civic Engagement

CUREs and the GWCC Mission

- The percentages of hispanic, black, and indigenous students attending GateWay CC have increased since Fall 2022.

- A high percentage of our students are first generation.

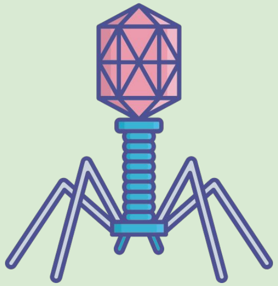




CUREs and the GWCC Mission

There are currently three instructors offering CUREs:

Dr. Jennifer Foltz-Sweat



Dr. Saroj Chirravuri

Mr. Herb Wildey

https://sites.google.com/phoenixcollege.edu/mcccdstemcure/home

Bee CURE

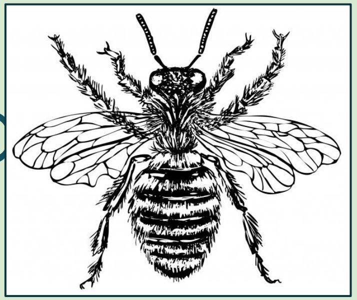
Wild Bee Ecology and Conservation CURE

Students contribute to bee ecology and conservation through authentic and meaningful research

Bee CURE

Wild Bee Ecology and Conservation CURE

- Ask questions, formulate hypotheses, iteration through methodology refinement, data collection and analysis.
- Ownership comes from selecting their own sample area and mining data to answer unique questions.
- Contributing valuable information about urban bee populations to be used for conservation.
- Dissemination to the scientific community and community partners.



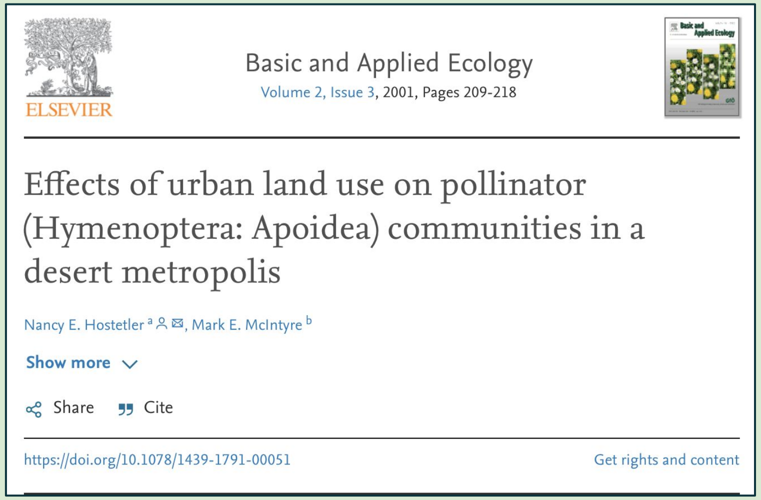
Bee CURE

Read scientific literature

Recognize common bees and plants

Select sample location

Learn sampling protocol


ELSEVIER

Basic and Applied Ecology

Volume 2, Issue 3, 2001, Pages 209-218

Effects of urban land use on pollinator (Hymenoptera: Apoidea) communities in a desert metropolis

Nancy E. Hostetler [a], Mark E. McIntyre [b]

Show more

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https://doi.org/10.1078/1439-1791-00051

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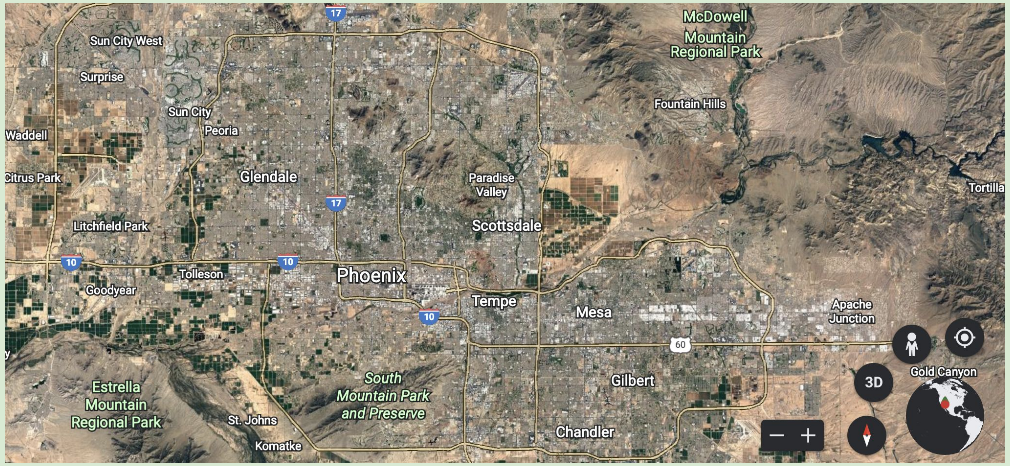


Bee CURE

Student groups identify unique questions related to bee ecology and conservation

Analyze data using group database

Which urban plant species attract the greatest number of bee species?

Which neighborhoods support more bees and why?

Is the urban bee community different in spring and fall?

Bee CURE

Plant Guide to Pollinator Friendly Arizona Plants

By: Christian Jimenez, Nathan Arrivillaga, Tiffany Floyd, & Traci Pepper

Texas Sage

Leucophyllum frutescens

Common Names: Texas Sage, Cenizio, Green Cloud Sage, Silver Cloud Sage, Chihuahuan Sage, Silverleaf, Texas Ranger, Barometer Bush.

Description: Greyish green shrub with purple flowers.

Where found: Widely cultivated in the Phoenix Metro area

Native/Introduced: Native to Texas and the Chihuahuan Desert, but cultivated in Phoenix.

Bloom: Spring through Fall. Blooms are brought on by rain.

Pollinator benefits: attracts honey bees

Bee CURE

Students researched sampling protocols then created a unique protocol for the CURE

Name
Date:

Field Data Table

Location(Approximate):
Weather Conditions:
Temperature:
Start Time:
End Time:

Type of Flower	**Type of Bee**	**Description (**color, size,distinct features, etc.)	**#of Bee**

Additional Observations:

	A	B	C	D	E	F		
1	Bee Spread Sheet							
2	Name	Date	Type of flower/plant	Description of Bee (color, size, etc.)	Number of Occurrances	Location	Time of Day (AM/PM)	Temperature
3								
4								
5								
6								
7								
8								
9								

Bee CURE

Student groups work with partners to disseminate findings

COLLEGE OF THE CANYONS

ANTELOPE VALLEY COLLEGE

CURE: NATIVE POLLINATORS' PLANT PREFERENCES IN URBAN ENVIRONMENTS

Lorena Martinez, Christian Jimenez, Jennifer Foltz-Sweat

Gateway Community College

Introduction & Abstract

There is a growing public interest in supporting native pollinators in urban environments, especially as we witness a notable decline in native pollinator populations worldwide (Potts et al. 2010) . Despite these concerns, most urban landscapes consist mostly of non-native plant species, which native pollinators have been observed to visit less (Lowenstein, D. M. et al., 2019). However, there is still lack of clarity on the relationship between bee species richness and native vs. non-native plants (Williams et al. 2011)

To gain more insight into how non-native plants affect bee species richness in the greater Phoenix area, we conducted an observational study on native bee populations over one year on 3 different college campuses with varying plant populations. Our preliminary data suggests that native plants supported higher bee species richness than non-native plants even though non-native had higher abundance.

Future Objectives

- **Continue collecting data on bee species richness between native and non-native plants.**
- **Create pollinator networks that display bee-floral host associations.**
- **Advocate for pollinator-friendly horticultural practices in urban environments**
- **In crease awareness by engaging students in pollinator research and pollinator-friendly gardening techniques.**

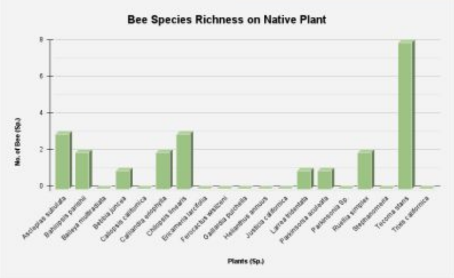
Entomemology. Instagram; [updated 2024 March 12; accessed 2024 March 13]. https:www.instagram.com/p/C4aV2mnr5pB/?igsh=MW94dDR5N243Y21rbg==

Methods

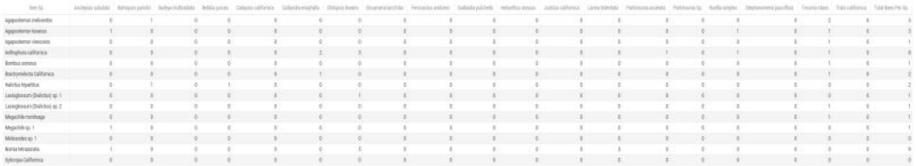
- Bees were collected using aerial netting during flowering months (March-April) (September-October) on community college campuses (Gateway CC, Mesa CC, Phoenix CC) between 8 am and 10 am under consistent weather conditions.
- Bees were curated and identified to the species level using "Common Bees of Western North America" by Olivia Messinger Carril and Joseph S. Wilson.
- Floral abundance and density were recorded each sampling period
- Plants were identified to the species level when possible and classified as native or non-native.
- There were a total of 12 sampling days. 5 sampling days at Gateway CC, 5 sampling days at Mesa CC, and 2 sampling days at Phoenix CC

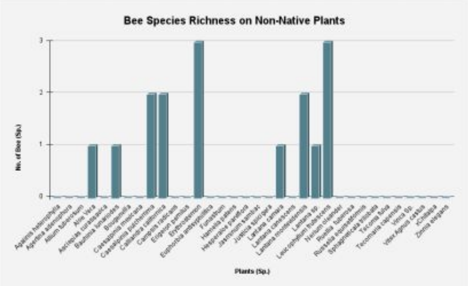
Results

*No statistical analysis done due to limited sample size

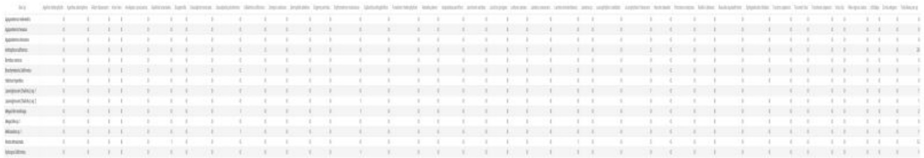


- **19 Native plants recorded**
- **9 of recorded Native plants showed bee activity**
- **12 bee species recorded on Native plants**
- **Total No. of bees found on Native plants: 33**





- **35 Non-native plants recorded**
- **9 of recorded Non-native plants showed bee activity**
- **8 bee species recorded on Non-Native plants**
- **Total No. of bees found on Non-Native plants: 39**



Conclusions

From our preliminary data we can note that the native plants between the three campuses supported higher species richness despite non-native plants being more present and with slightly higher pollinator abundance. Non-native plants may be more cost effective and easier to maintain, however our data indicates that urban pollinators may benefit more from landscapes utilizing more native plants.

The Maricopa Native Seed Library is an excellent source for students to learn about native plants and experiment with pollinator gardening, but installing pollinator gardens in schools and urban landscaping could provide more impactful opportunities to increase awareness of pollinator decline and appreciation for the approximately 1000 bee species that call the Sonoran Desert bioregion home.

References

Lowenstein, D. M., Matteson, K. C., & Minor, E. S. (2019). Evaluating the dependence of urban pollinators on ornamental, non-native, and 'weedy' floral resources. *Urban Ecosystems*, *22*(2), 293–302. https://doi.org/10.1007/s11252-018-0817-z

Potts SG, Biesmeijer JC, Kremen C, Neumann P, Schweiger O, Kunin WE. (2010) Global pollinator declines: trends, impacts and drivers. Trends in Ecology & Evolution, 25(6):345–353. https://doi.org/10.1016/j.tree.2010.01.007

Williams, N. M., Cariveau, D., Winfree, R., & Kremen, C. (2011). Bees in disturbed habitats use, but do not prefer, alien plants. *Basic and Applied Ecology*, 12, 332–341.

Acknowledgments and Contact

Bat CURE

Bats
Course : BIO 182: Biology for Majors II
In person offerings, continuation projects

Fall 2025
Course BIO 181: Biology for Majors I
SEA PHAGEs: Discovery

Bat Cave Explorers

Phoenix Bat Cave Diet Abundance

Adria Laborin

GateWay Community College: A Maricopa Community College, Phoenix, AZ

Abstract

The purpose of this exploration is to develop a broad understanding of the diet composition of bats roosting in the Phoenix bat cave. For about 20 years, a population of varied bats, most of which are Mexican free-tailed bats *(Tadarida brasiliensis)* , have roosted in the Phoenix flood control tunnel. This tunnel is now known as the Phoenix bat cave, and is located in north-central Phoenix adjacent to the canal. Between the months of May and October, large populations of bats will migrate north to Arizona and roost in the tunnel to reproduce. In order to examine the diet of the bats roosting in the tunnel, guano samples were collected and analyzed using PCR technology. The results indicated a diet consisting of various insects and arthropods. The most abundant of which were *Diptera, Lepidoptera, and Coleoptera* (flys, moths, beetles) in order of abundance. These results did not deviate from what was previously known, however with the use of PCR, the species within the phylums being consumed were identified. This information is unique to the geographical area and has not been previously documented. The results of this study can be used in the future to better understand the unique ecosystem surrounding the Phoenix bat cave and catalog population trends of insects.

Background and Introduction

Since the late 1990's a population of bats has been observed, roosting in the Phoenix flood control tunnel.Recent estimations state that, at the height of summer, there may be up to 20,000 bats roosting in the

Methods

In order to analyze the diet of the bats residing in the Phoenix bat cave, guano samples were collected and analyzed as follows:

-Two areas were selected for guano collection within the cave, at least 20 yards from the opening. Collection areas were up against the tunnel walls, in order to allow service vehicles to drive through without disturbing the collection tarps.

-The selected areas (one on the south side and one on the north side of the tunnel) were swept clean using a broom.

-A large 10x20ft tarp was then layed out at the cleaned collection sites and weighed down using rocks in order to prevent any wind from disturbing the tarps.

-After a period of two weeks, the guano pellets were collected from the tarps. The pelleds were collected using steel pickups and placed in plastic vials labeled north or south depending on which tarp they were collected from. A total of five completely filled vials were collected from each tarp.

-In order to analyze and catalog the insect/arthropod DNA found in guano PCR testing was conducted via the NAU Pathogen and Microbiome institute. The samples were split into ten groups for analysis labeled A-K. During PCR (Polymerase Chain Reaction) testing DNA was extracted from the guano and amplified multiple times using a specific primer. After the DNA was amplified and isolated it was identified using known genetic catalogs. The results were then reported using standard spreadsheets.

From left to right: 1. Students collecting guano samples on a cave visit on 3/31/21. 2. Reference photo of bat guano pellet collected (multiple pellets were collected per sample tube) 3. Researcher collecting guano sample from a tarp on a cave visit 3/31/21.

Results

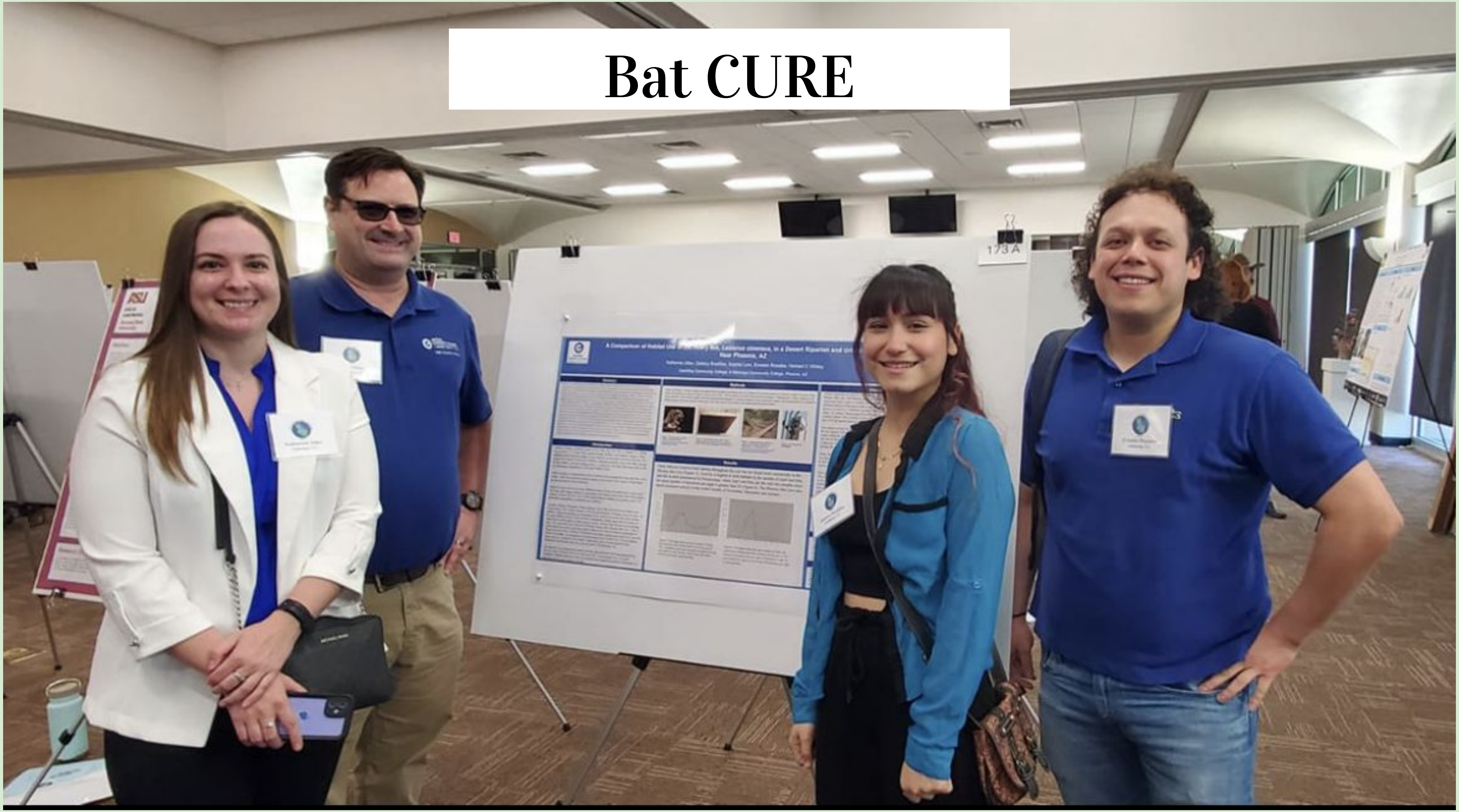
Discussion and Conclusion

The intention of this project was to develop a further understanding of what the bats residing in the Phoenix bat cave eat. However, for future explorations it is important to consider what these results mean. The bats residing in the bat cave are part of a complex ecosystem. What the bats eat can provide information on what types of insects live in the areas surrounding the cave and how the bats contribute to their surroundings by eating these insects.

The most commonly detected *Diptera* found in the guano were *Euarestoides acutangulus*, a type of fruit fly. While extensive information on this fly was not found, fruit flies of the *Tephritidae* family are known pests which can damage crops (Benelli and Giovanni, 2014). The area around the canal was once a citrus grove and many of the trees remain. It would be interesting to explore if the population of these flies is affected by the bats consumption of them. In turn it may be possible to investigate if the bats aid with citrus growth by reducing the population of fruit flies. The second most common *Diptera* found was *Drosophila nigrospiracula*, this fly is native to the sonoran desert and breeds in decomposing saguaro and cardon tissues (Polak, 1996). Bats, being good samplers, may help ecologists notice a spike in the population of this fly. This could indicate an issue with saguaro populations in the surrounding area.

In terms of *Lepidoptera* it is important to consider the physical size of moths relative to the data reported. *Lepidoptera* are largely abundant in the data however, they are much larger than flies. Therefore, their abundance does not mean that a larger number of them are being consumed. Observation of the data provided, indicated that the most common *Lepidoptera* found in the samples are not specated. This could indicate that there may be a moth (or multiple) in the area which still need to be cataloged in the banks used to identify species, when using PCR testing. The second most common moth found is *Filatima albicostella*, a common broadwinged

Bat CURE



Bacteriophage CURE

Bacteria and Bacteriophages
Course: BIO 205 : Microbiology
SEA PHAGES(discovery) pilot project

Fall 2025
BIO 205: Microbiology
CRISPR editing

Isolation and Characterization of Nitrogen Fixing Bacteria from the Guayule Rubber Plant

Marbe Lopez, Juliet Marquez, Jeremiah Rosas, Cherlyn Tatum
Led by Saroj Chirravuri, Professor of Microbiology, Gateway Community College

Abstract

Our research team went to the US Arid Land Agricultural Research Center in Maricopa, AZ to collect root and soil samples from the guayule rubber plant. In the lab, we isolated the bacteria attached to the roots of a plant from the hundred percent hydration zone. We isolated bacteria attached to the roots of plants to observe the relationship between the guayule rubber plant and nitrogen fixing bacteria. We isolated certain bacteria and are still in the process of obtaining results.

Introduction

There is a symbiotic relationship between plants and microorganisms which help them develop the structure and functions needed to survive. The plant microbiomes are very diverse but our main focus in our research is Nitrogen Fixers. Nitrogen is a crucial element to help promote plant growth and production. Now nitrogen fixer's can be found in most plants while others collect this gas through air and store it in their roots.

Our focus is on a rubber producing shrub which produces nitrogen fixing bacteria to grow. This shrub is called P. argentatum. Scientific name, Genus: Parthenium, Species: argentatum also known as "guayule". The specimen was collected from the U.S Arid Land Agricultural Research Center in Maricopa, AZ where we had the pleasure of meeting Diaa Elshikha, a research associate from the University of Arizona. We collected root samples and soil samples from fifty percent and hundred percent shrubs. The percentages signified the amount of water that the rows of guayule shrubs were given. We collected samples from the rhizosphere to hopefully find nitrogen fixing bacteria. The rhizosphere is very important to the plant since it contains growth promoting rhizobacteria around the root and soil closest to it.

Our method of collection involved aseptic technique to collect our specimen in its purest form to avoid cross contamination. At the lab we ran several different tests and plated our specimen on a series of different agar to cultivate microorganisms from our samples. We originally started to test soil samples with the dilution method on 50% soil but we did not successfully have growth. This lead us to begin tests on 100% root samples. The nitrogen free medium was used to plate 100% root. We had growth on this medium meaning that this is a nitrogen fixer. We also found rod shaped microorganisms which was our break through finding after many other tests.

Methods and Materials

- Blue Cap tube holds 45 ml total 12 centimeters 14.09grams empty container
- Blue cap tube weight with all the soil in the container 38.16g
- Fill first Tube with 10ml the rest 9ml, 10 tubes total
- Zeroed out tray weight pure weight of soil is 2.020g
- Place tube in vortex mixer
- 1000 Micrometer pipet 100 is the measurement the pipet should be placed on
- We used the pipet to take out 1ml for each dilution 10-2 up to 10-9
- Roots were measured from 1-2cm length

After having a total of 9 dilutions we plated each dilution on white agar called Actinomycete Isolation agar on dilutions numbers 10-9, 10-8, 10-7, 10-6.

Results

The results for our initial test, 50% soil, yielded no results. Because of this, we had to switch our microbial strain from 50% soil to 100% root. The first test we did for the root 100% root sample was performing the catalase test. We took a sample of the root and streak the nitrogen free medium. After that, we poured one mL of hydrogen peroxide solution, of which the root sample streak did show a positive result for the catalase test. Next, we performed an oxidase test by using Kovac's oxidase reagent. We did not find any oxidase in the root sample. After that, we performed the starch hydrolysis test. We used the starch agar as the differential medium, and after we inoculated this plate, incubated at the required temperature, and flooded the growth with iodine it was evident that the hydrolysis of starch was present in our sample. The gram stain was a simpler test, we inoculated the slide and followed the correct procedures to come to the final conclusion that our root sample was gram positive. Finally, in our motility test, we found there to be motility in our root sample after allowing the growth of our bacteria in our selective medium.

Appearance of colonies on Media

Catalase test

Oxidase test

Starch Hydrolysis

Gram Stain

Motility

Discussion

The test we conducted included-Colony Characterization , Gram Staining, Catalase Test, Motility and indole test in SIM Medium, Starch hydrolysis in Starch agar. We used BMS media to help enrich the bacteria and grow more colonies.

Further biochemical test and DNA analysis is needed to confirm the identity of our N fixing microbes. If there are no matches to currently known Nitrogen fixers, we would need to repeat our experiments, identify Nitrogen fixing genes as well as compare with other known microbes.

Regarding experimental procedures and sampling . Maybe for the soil portion we needed a larger quantity of soil or a small quantity in milliliters of water. Also less dilutions maybe only 6 dilutions instead of 10 dilutions that way we still had product in the water dilution that we conducted tests on.

If we isolate N fixing bacteria and are able to characterize them properly our next steps would be to consider using them as biofertilizers to improve soil quality around Guayule plants.

Conclusions

We isolated the bacteria from the soil of the guayule plant and sent it to the lab for further processing. The results of this project are inconclusive because we have not received the data in regards to identifying the bacteria. Bacteria that are known as "nitrogen fixers" can increase the abilities of the plants to utilize the biological nitrogen fixation process to convert inert nitrogen gas into a sustainable form of nitrogen. By determining how to increase naturally occurring bacteria that are known nitrogen fixers and engineering environments in which they will prosper, the use of artificial fertilizers can be decreased which will be helpful to people and the environment.

References

1. [illegible]

Amazon Prime: Research Journal into Antibiotic Producers of The Amazon Rainforest

Bohden Lomahquahu, Dawn Burress, Erich Ludwig, Hai Lam, Sabrina Griffin

BIO205 Dr. Saroj Chirravuri

Introduction

Antibiotic resistance has been an ever-increasing worldwide dilemma, not long after Penicillin was discovered less than a century ago. Penicillin represented the technological breakthrough that led to the exponential growth of antibiotic research and was incorporated into medicinal practices. Since then, it has saved millions of lives and transformed the healthcare system around the globe. Unfortunately, the misuse and overuse of antibiotics have created a very real and present danger, as resistance to treat multidrug-resistant bacteria has been a rising cause of deadly health complications.

Background

To this end, The Tiny Earth project was launched in 2012 with the goal of potentially finding new antibiotic-producing microbes from around the world, but also to engage a new generation of microbiology students in a hunt for the solution to a present and growing health crisis (Martin et al., 2019). In conjunction with The Tiny Earth project, our Biology 205 class at Gateway Community College has utilized our recently acquired laboratory and research skills to test samples in the search for potential antibiotic-producing bacteria.

Our chosen soil sample is from the Amazon peatlands near Iquitos, Peru. (Finn et al., 2020), and accordingly, our team name and research project is titled Amazon Prime. Our soil sample was curated by a Ph.D. candidate from Arizona State University, who has also been conducting other research on the soil. It was our goal to find antibiotic-producing microbes in our given soil sample potentially.

Process Soil Samples

After collecting soil samples, we decided to dilute our sample to get a smaller amount of microorganisms. We labeled 6 tubes from 10^{-1} to 10^{-6} while adding 9.0 mL of water. We then added 1.0 mL of solution from the original soil solution and added it to a 10^{-1} sample. Repeat this step but grab 1.0 mL of sample from the previous tube before moving to the next tube and ALWAYS change pipettes.

After all tubes are done and filled with diluted solution we grabbed NA plates and placed 1.0 mL of solution on the NA plates. We used a spreader to spread out the solution and incubate the plates at 37° Celsius for at least 24 hours and watch for growth.

After returning we found there was zero growth on our four plates. We decided to repeat this process and try again. As we waited and our next plates were ready we had found some growth on some plates.

Isolated Culture Specimens

Following the plating of the second set of serial dilutions, growth was noted on all of the inoculated plates, with the greatest growth found at dilution levels 10^{-3} and 10^{-4}. A Colony Forming Unit (CFU) count was performed and a CFU count of >100 was recorded for plates 10^{-3} and 10^{-4}. Plates 10^{-5} and 10^{-6} were determined to be Too Few To Count (TFTC).

Sixteen colonies from each of the 10^{-3} and 10^{-4} plates were randomly selected and patched in a grid-like pattern four across and four down on both NA plates with anti-fungal (Nystatin) and AIA plates.

Samples from each plate of the dilution level 10^{-3} and 10^{-4} were semi-quadrant streaked on plates of NA in an effort to obtain pure cultures. These plates were then incubated at 37° Celsius until the following laboratory day. Pure samples were obtained from the semi-quadrant streaks and Gram Stains were performed. All Gram Staining revealed large Gram-positive cocci in no particular arrangement.

To test the isolated cultures for antibiotic-producing capability, three plates of NA were first inoculated with various known bacteria; E. coli., S. aureus, and S. epi., were chosen and placed onto the plate and spread with a sterilized spreader. Samples of the isolated cultures from dilution levels 10^{-3} and 10^{-4} were then placed in a circular manner with eight samples per plate of each known bacteria.

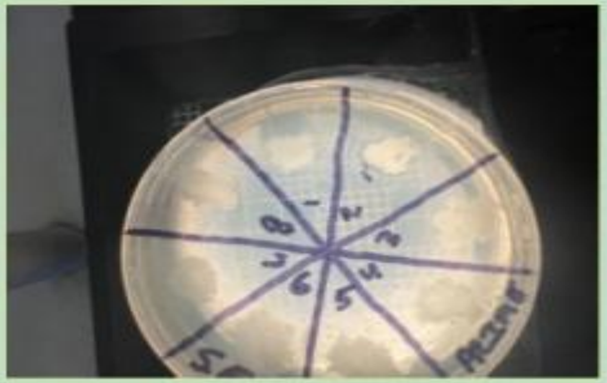
The plates were incubated at 37° Celsius until the next laboratory day.

The 'Amazon Prime' team identified that none of the selected samples of the dilution level 10^{-3} and 10^{-4} on any of the three plates inoculated with known bacteria displayed antibacterial properties. Further isolation and testing of cultures from the Amazon peatlands are warranted.

Results & Conclusions

The results of our research were mixed. Our original incubation showed no samples with antibiotic-producing capacity; however, after recreating the project a second time we discovered one culture that potentially has the ability to produce antibiotics against S. Epi.. This culture displayed a slight but observable clearing around it. This may indicate the cultures' antibiotic capability. Further study is required to understand why on the second set of plates samples from the Amazon peatlands made antibiotics. One conclusion would be that on the second try, the team was able to ensure proper growth without introducing outside microbes to the test. A second conclusion would be that, on the second try, the isolated bacteria were properly "stressed" enough to encourage the production of antibiotics.

Antibiotic resistance is a danger the world faces and it may be possible the answer to this lies in the peatlands of the Amazon.



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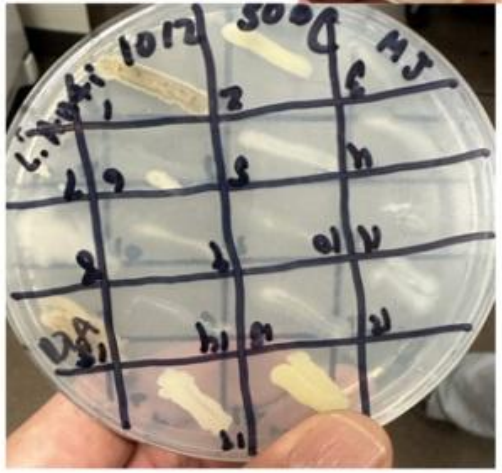
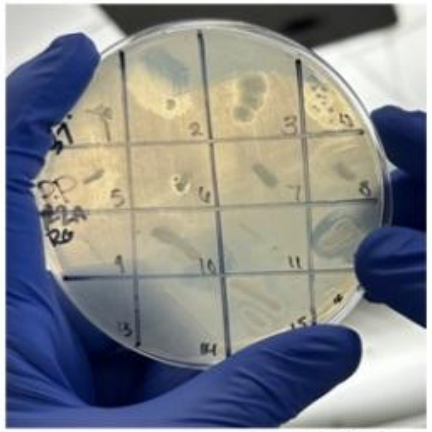
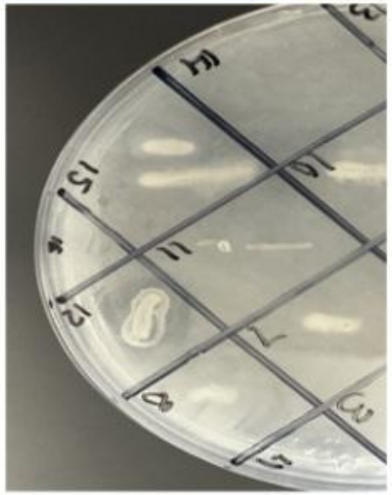
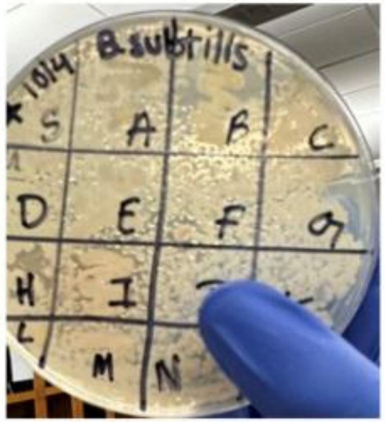
Additional Information

Images from Fall 2023 CURE









tiny earth

studentsourcing antibiotic discovery

- Soil samples were diluted and plated.
- Microbes were patched and saved for testing
- Microbes were patched against safe relatives of common pathogens to look for antibacterial activity.
- Biochemical tests are in progress to help with identification.
- Prospective samples will be sent to UWM/Tiny Earth scientists to purify and characterize active ingredient.

Bacteriophage CURE

- **Science Education Alliance (SEA)-**

  Phage Hunters Advancing Genomics and Evolutionary Science (PHAGES)
- **Training funded by Howard Hughes Medical Institute (HHMI)**

3-year commitment

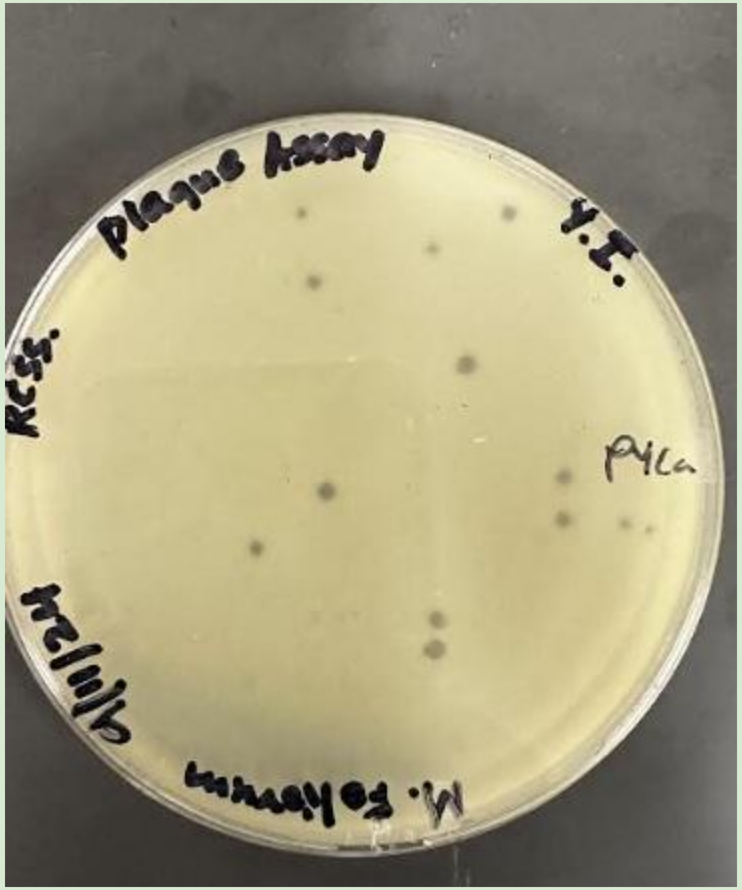
2 courses

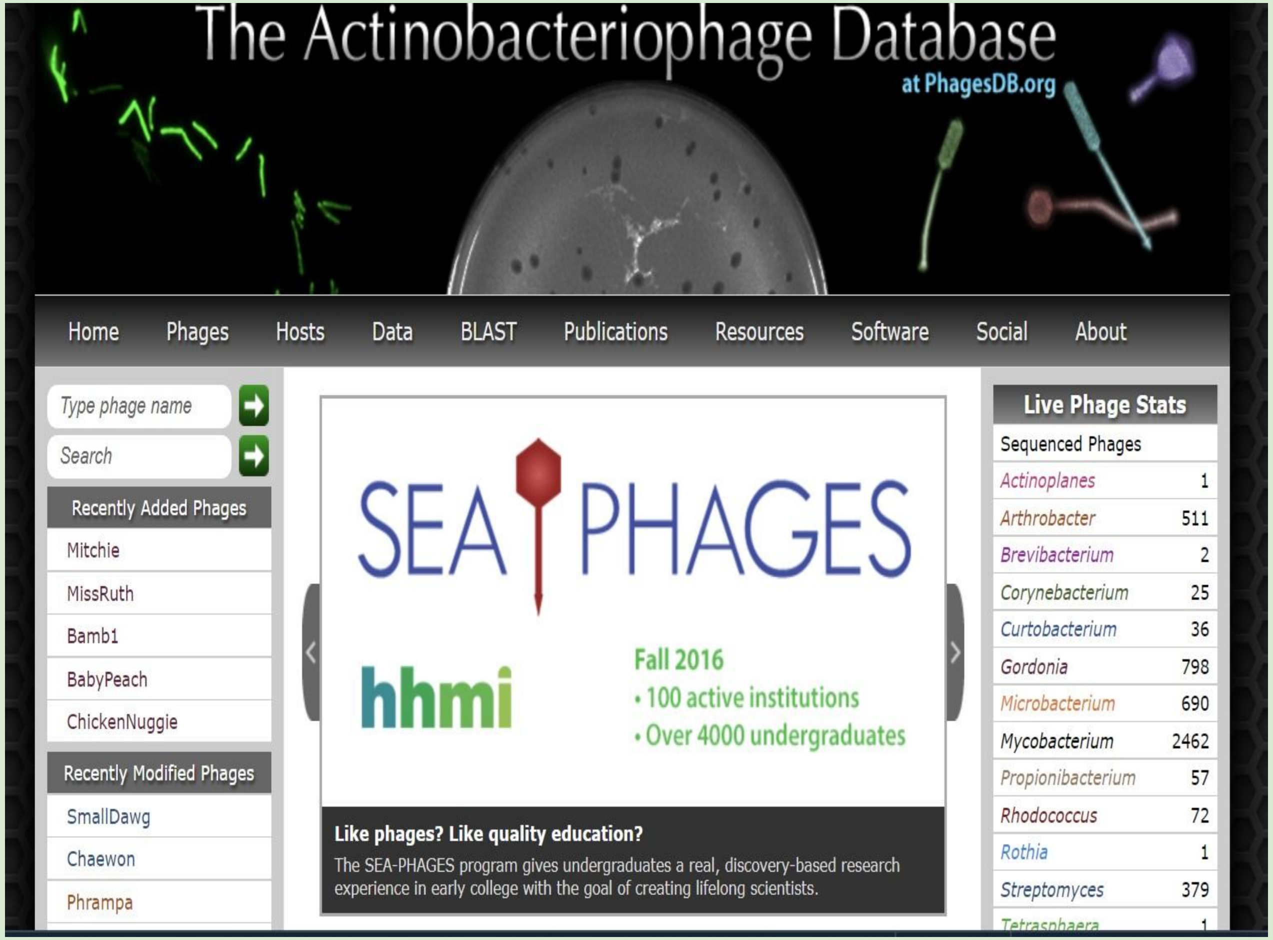
Phage DIscovery

Phage Genomics

Students get to isolate viruses, take EM pictures, isolate the DNA and then sequence the DNA.

Bacteriophage CURE





How do the students find us- Student Outreach

STEM CURE- no special mention of this when students sign up.

More aggressive marketing approach, with videos and flyers.

General Education Designations: SG

SUN# BIO2205

Class#	Location	Delivery	Dates	Days	Times	Instructors	Availability
11748	GateWay IE Bldg - Classroom IE-2213	In Person	08/19 – 12/11 Fall 2024	M,W	9:30AM – 10:45AM	S. Chirravuri	**Class Started** Contact Enrollment Services for Registration Assistance

- Costs include BIO Course Fee: $45.00

▼ Notes

Notes: In Person classes meet face to face on campus in designated classrooms at specified dates and times. CANVAS is used as the learning management system.

This class may also have optional in-person field trips as it has an undergraduate research component.

As a CURE*, this course provides the opportunity for students to gain valuable experience by contributing to an authentic scientific study. (*CURE=course-based undergraduate research experience)
Class 11748 costs include BIO Course Fee: $45

Lab Notes: Students enrolling in class 11748 must also enroll in the following lab:
Class 11749 held Mon/Wed from 11:00AM to 12:15PM at IE 3207 (S. Chirravuri)

We now have a note in the sign up for classes that indicates that these classes have special projects

Student Outreach

- Promotional Flyers
- Posters and Testimonials
- Scholarship Opportunities
- Changing the offerings to courses that traditionally have more enrollment.

Student Outreach

https://www.youtube.com/watch?v=wWcIQZtCse0

Incentives for Students

- $500 scholarship to take a CURE class (For the CURE)
  - must write a letter about why they are interested in undergraduate
  - research.
  - Must be Pell grant eligible.
  - Must have a certain GPA

- Students can make the class an Honors class, and get tuition credit.

Faculty Development and Growth

Skills
Training in new techniques by attending workshops
Conducting workshops to train future faculty in logistics of CUREs

Diversity, Equity and Inclusion in pedagogy
BRIDGE Academy
ALRISE Alliance and ALRISE grant
Culturally Responsive Pedagogy Workshop

SEA PHAGES Training

Three residential faculty, one adjunct and one lab technician, 3 year commitment.

Learning the lab skills and bioinformatics at summer and winter workshops .

Tiny Earth and SEA PHAGES have a lot resources, are well-established, have databases, offer lab books and instructional videos, have communities of practice, office hours etc. They also offer help with publication costs and logistics.

Gateway Community College Initiative

BRIDGE academy workshops were a NSF grant funded opportunity for colleagues to meet and analyze their own bias, mindset and build an understanding of how to develop more equitable teaching practices.

GateWay Community College

BRIDGE Academy

Inclusiveness In Curriculum

Building Relationships through Intersectional Dialogue and Greater Engagement

ALRISE Alliance and Arizona State University

ALRISE is a five-year, $10 million cooperative agreement with the Eddie Bernice Johnson National Science Foundation INCLUDES Alliance to Accelerate Latinx Representation in STEM Education (ALRISE) with Institutional Intentionality and Capacity Building for Experiential Learning.

- ❑ Culturally responsive practices with experiential learning programs that positively impact student outcomes.
- ❑ Professional development, tools, and resources that infuse intentionality into experiential learning programs
- ❑ A model and theory of improvement that accomplishes intentional acceleration and scale of Latinx representation in STEM.

NSF INCLUDES ALRISE ALLIANCE

ALRISE Alliance Lead and Backbone Organization

Arizona State University

C. VanIngen-Dunn, A. Tanguma, S.McCabe, A.Key, Kathryn Claypool

Advocacy and Policy

D.Santiago

HSI Identity and Intentionality (HSI3) – J. Rocha & M. Lopez

Undergraduate Research (URE) Networks

S.Haydel, R.Cotter, P. Baker

Work-based Experiences WBE) & Industry

S. Padilla & S.Zylstra

Research & Evaluation Team –

F.Herrera-Villareal & L.Arellano

Regional Hubs Manager, A. Tanguma-Gallegos

Western Hub

Southwestern College

Regional Hub

Mourad Mjahed, Silvia Nadalet-Leads

Genesis Lastrella-Hub & EL Coordinator

HSI and eHSI Members

- Southwestern - CA
- Riverside City - CA
- San Diego City - CA
- CSU San Bernardino - CA
- LA Mission College-CA
- San Joaquin Delta - CA*
- LA Harbor College *

Southwestern Hub

Phoenix College

Regional Hub

Adrianna Coronel, CJ Wurster-Leads

Gabe Noga -Hub coordinator &

Rosalind Cook -EL Coordinator

HSI and eHSI Members

- Phoenix - AZ
- Central Arizona - AZ
- Gateway - AZ
- Northeastern Illinois - IL
- Arizona Western - AZ
- ASU West - AZ

South Central Hub

Palo Alto College

Regional Hub

Katherine Doss, Erron Gonzalez-Leads

Mayrismir Cordero-Hub & EL Coordinator

HSI and eHSI Members

- Palo Alto - TX
- UT San Antonio-TX
- UT Dallas- TX
- Laredo CC-TX
- University of North Texas
- Doña Ana CC-NM
- Central New Mexico CC-NM
- New Mexico State University
- Pontifical Catholic University of Puerto Rico

Eastern Hub

Miami Dade College

Regional Hub

Diego Tibaquira,Niurka Goenaga-Leads

Justin Estevez-Hub & EL Coordinator

HSI and eHSI Members

- Miami Dade - FL
- Indian River State - FL
- Growth in FL, MD, NY, PR

* Network

Backbone Team

Arizona State University

Center for Broadening Participation in STEM

ALRISE and PDSA

- Regular meetings and communities of practice for UREs as well as Service Learning -
- Gave us tools to implement in the classroom to get past deficit minded approach, verbiage in syllabus to be more student friendly
- Each college has its own PDSA -Plan Do Study Act document.
- Each participant has their own Reflexivity Sheet (Lopez & Rocha, 2024)

Attendees at the CRP training in May 2024

Logistics

- Have support from Division, Deans, VPAA and College President.
- Risk Assessment may be an issue.
- Have needed MTAs and other legal clearances for research
- IRB certifications and approvals
- **Communities of Practice** Undergraduate Research Across the Curriculum @MCCCD- To expand the cohort of faculty offering equitable CUREs and t o support those that already offer them.

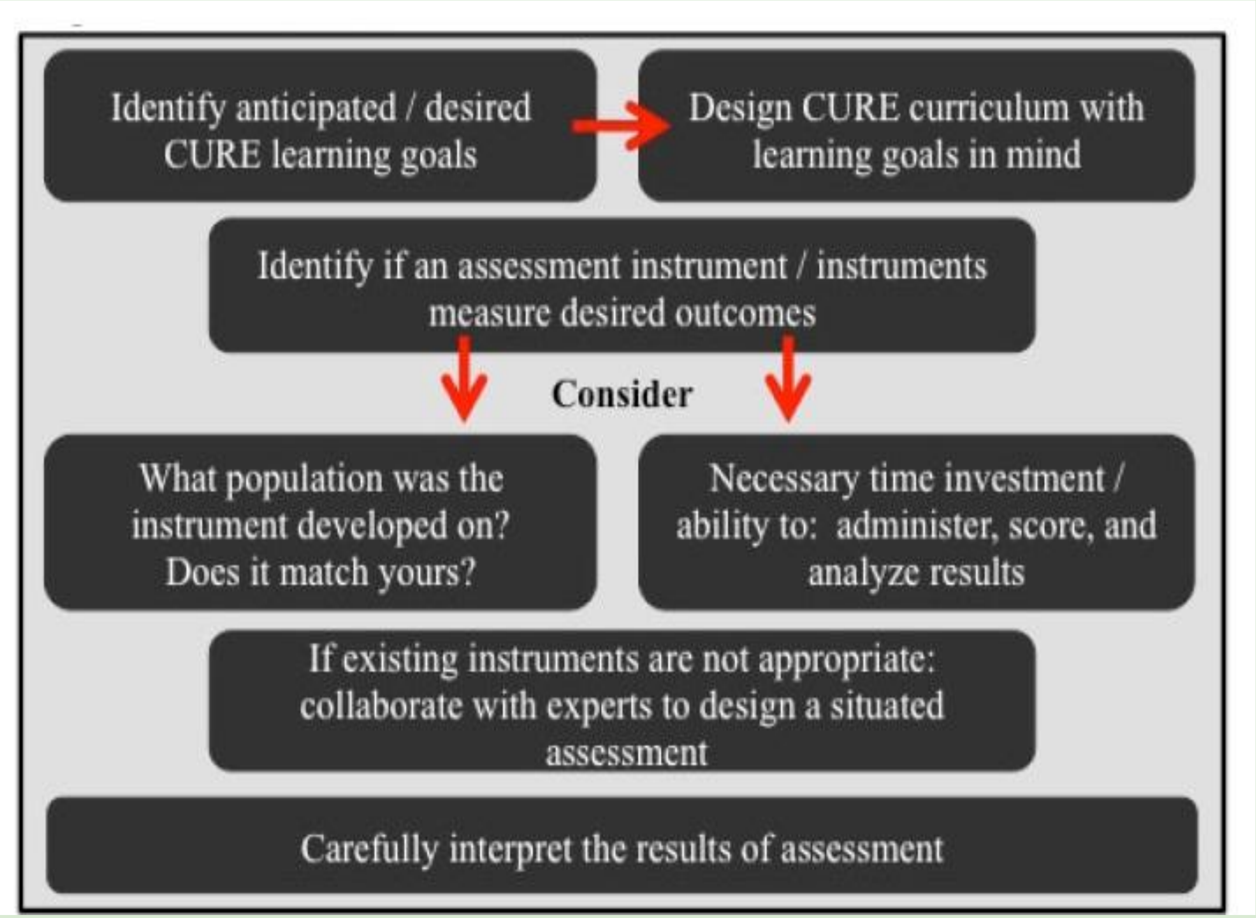
Sustainability- Grants and Funds

- Materials through the STEM CURE grant (NSF), mentoring and a community of practitioners
- Increased Course Fees (for labs) but mitigating via OER textbook use.
- ALRISE grant proposal in the works ($20K)
- NSF IUSE grant proposal being considered.

Future Plans

- ❑ InnovATE Bio - Attended conferences about what the workforce of the future should look like and **what skills students need**
- ➔ -State of the art lab skills
- ➔ -Critical thinking and research skills
- ➔ -Quantitative analysis and reasoning skills
- ➔
- ❑ College may offer AAS in Biotechnology.
- ❑ Connections made with **Cold Spring Harbor Labs** scientists
- ❑ Participating in CRISPR related grant out of **Pike Peak College**- Creating CUREs in Gene Editing for all Students)

Closing the Loop



Have not used any formal instruments of assessment of impact.

The methods of assessment would have to be appropriate for community colleges and assess for-

- Content based assessment
- Self Efficacy, Self Confidence, Science Identity Impact

Shortlidge & Brownell (2016)

Student Feedback

Yes, I did find the research project interesting. I would take another class with research projects.

The class project was a really good one, I believe it should stay as the final project for the future classes. yes!

The class research project has us working with people from all over to try to find new antibiotics, that's something that could benefit everyone, that's really cool and exciting.

It was interesting and I find that it can have some real good meaning. You never know maybe someone some day will find a bacteria that produces the next new antibiotic.

I think the research project was interesting when it came down to doing different labs to see what bacteria would be in the soil, we collected but the overall project had me a little confused on certain things. I wouldn't choose another class just have more depth to the project.

It was interesting, however, I would not willingly choose another class with original research projects

It had the potential to be but we were informed that we were doing it just to do it and weren't really informed on the importance of the projects moving parts which kinda sucked. No I would not do this again.

Challenges for Instructors

- Lack of enrollment. Misconceptions about what the note on class registration means in terms of commitment.
- Some students upset at required group work.
- Students expect structure and predictability.
- Some students do not benefit because of their end goal.

- Planning and execution, iterations takes time and commitment
- Initial set up is costly-Community colleges have limited supplies and equipment.
- Sustainability and Expense-Continued monetary support for chemicals, equipment, etc.
- How do we keep expanding on the data we are collecting? How to keep growing the CURE and institutionalization.

Other Outcomes

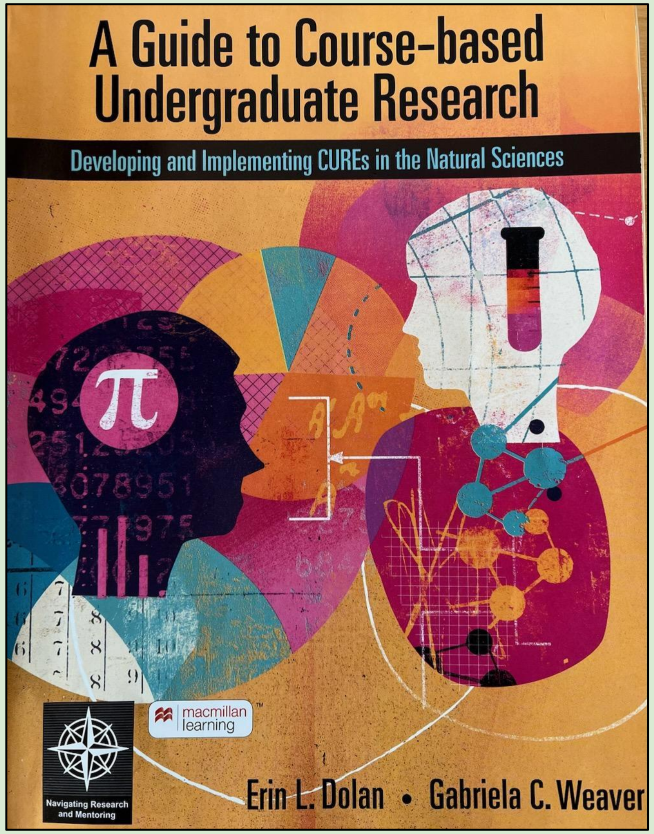
- Student Posters (at Arizona Nevada Academy of Sciences)
- Students coming back as peer mentors and tutors
- Chance to continue their work in future semesters
- Students move on to other CUREs
- Resume booster
- Chance to have their bacteriophages sequenced
- Publications
- Names in databanks
- Confidence to apply to research based positions

Basic Guidelines for CURE creation

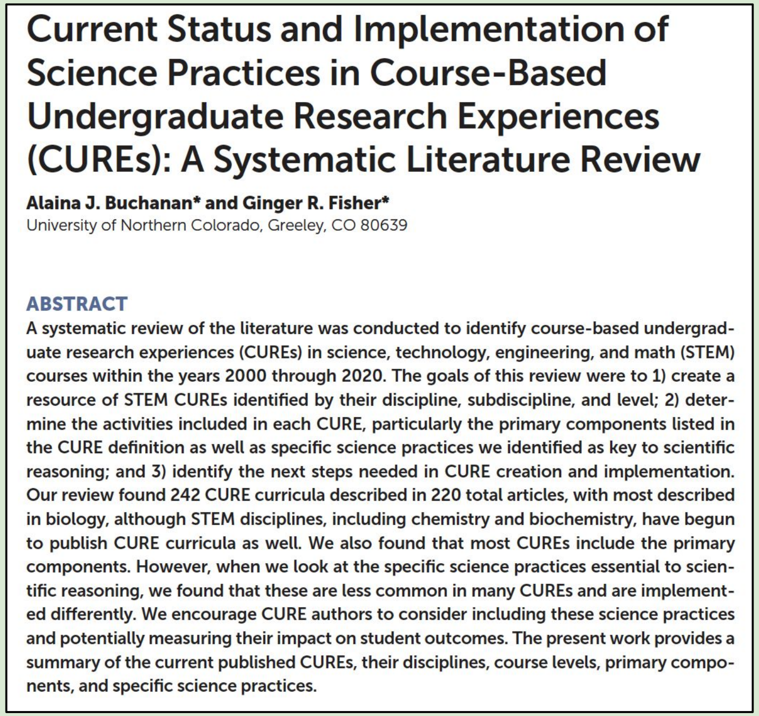
- Pick a high enrollment course.
- Plan around the competencies.
- Plan for appropriate assessment strategies. One size does not fit all.
- Plan for contingencies and expense.
- Is it sustainable?
- Consider your own level of commitment.
- Look for partners. Look for buy in from the college.

Resources To Help with Any Level of CURE Creation

serc.carleton.edu/curenet/



ISBN 978-1319367183



Current Status and Implementation of Science Practices in Course-Based Undergraduate Research Experiences (CUREs): A Systematic Literature Review

Alaina J. Buchanan* and Ginger R. Fisher*
University of Northern Colorado, Greeley, CO 80639

ABSTRACT
A systematic review of the literature was conducted to identify course-based undergraduate research experiences (CUREs) in science, technology, engineering, and math (STEM) courses within the years 2000 through 2020. The goals of this review were to 1) create a resource of STEM CUREs identified by their discipline, subdiscipline, and level; 2) determine the activities included in each CURE, particularly the primary components listed in the CURE definition as well as specific science practices we identified as key to scientific reasoning; and 3) identify the next steps needed in CURE creation and implementation. Our review found 242 CURE curricula described in 220 total articles, with most described in biology, although STEM disciplines, including chemistry and biochemistry, have begun to publish CURE curricula as well. We also found that most CUREs include the primary components. However, when we look at the specific science practices essential to scientific reasoning, we found that these are less common in many CUREs and are implemented differently. We encourage CURE authors to consider including these science practices and potentially measuring their impact on student outcomes. The present work provides a summary of the current published CUREs, their disciplines, course levels, primary components, and specific science practices.

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Questions?

Acknowledgements and References

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López, M. and Rocha, J. (2024, May 10). Invitation to a Mindset Shift: Embrace Culturally Responsive Reflexivity [PowerPoint slides], Center for Broadening Participation in STEM. Arizona State University.
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STEM CURE Grant- National Science Foundation, Grant No. 1832543.
U.S. Department of Education, National Center for Education Statistics, Integrated Postsecondary Education Data System (IPEDS), Completions component, Fall 2022 (provisional data). See *Digest of Education Statistics 2023*, tables 318.45 and 321.30.
U.S. Department of Health and Human Services (2021). HHS releases health workforce strategic plan. America's Essential Hospitals. Retrieved September 26, 2024. https://essentialhospitals.org/policy/hhs-releases-health-workforce-strategic-plan