Course-Based Research Experiences to Crowdsource Antibiotic Discovery

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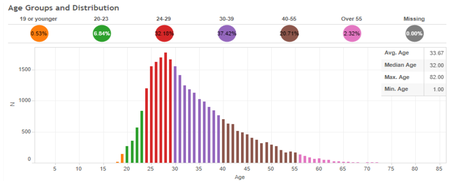
INTRODUCTION

- Only 40% of students who enter college with an intent in majoring in STEM fields end up graduating with a STEM degree, and about 20% of minority underrepresented students succeed.
- There is a high demand for a skilled workforce in STEM. 92% of STEM jobs will require a college education and training.
- Given this mounting need, offering authentic research experiences is a powerful tool for student engagement that results in increased retention, persistence, and graduation rates.
- Students who engage in research early in college are more likely to persist in STEM majors, receive better grades, and complete their degrees quickly.
- The Small World Initiative® (SWI) is an innovative program that encourages students to pursue careers in science while addressing a worldwide health threat – superbugs - and the diminishing supply of effective antibiotics.

AIM

- Introduce research methodology to undergraduate microbiology students.
- Validate a processing protocol for properly evaluating and discovering antibiotic-producing isolates from ocean and soil samples.
- Identify species or strains at the genomic level using 16SrRNA sequencing.
- Inspire and train the next generation of scientists.
- Solve two problems: a national mandate in science education for addressing low retention in STEM and a global issue in infectious diseases for addressing the lack of new antibiotics.

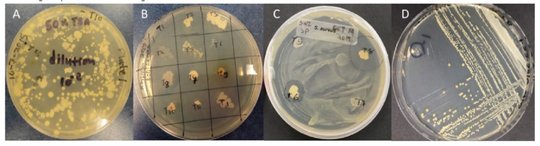
Student Ethnicity and Age Diversity Breakdown at National University



White	35.09%
Hispanic	27.52%
Black/African American	9.22%
Asian	7.93%
Two or more races	5.05%
Hawaiian/ Pacific Islander	1.03%
Not reporting	14.16%

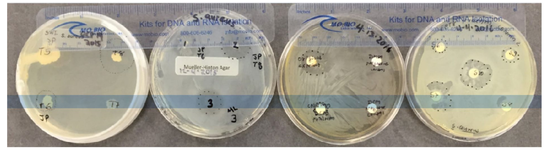
METHODS

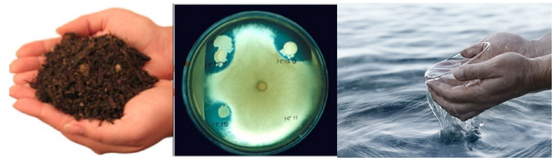
- BIO 203/A: 8-week lecture + lab, mainly for pre-allied health (pre-nursing and pre-public health) students
- Total of 8 class meetings, 7 hours each
- Half lecture and half lab sessions on Tuesdays and Thursdays
- Protocols were adapted from the Small World Initiative (smallworldinitiative.org)
- Students were asked to collect: Local soil, ocean water samples, and swab for microbes attaching to ocean plastic debris.
- Student perception of this CURE was assessed through surveys and open-ended questions, and focus group interviews.
- Thematic questions pertained to laboratory skills, interest in science, and research at teaching and RO1 institutions.



Student voices and comments

- *"It's not everyday that students get to perform one significant lab experiment of extracting bacterial DNA. The group of five students' curiosity has given us a whole new level of understanding of the numerous microbes living in our environment and through this experiment, it has generated an impressive DNA sequencing result."*
- *"I think class today was super cool and fun. I felt like a scientist."*
- *"It was an undeniable assertion that we have learned a great deal of information from this Microbiology class, however, this lab experiment has been one of the highlights of this 8-week course."*
- *"The smaller focus groups allowed more one on one time and a better environment to ask questions. All the panel members were helpful, but I felt there were some points in the lesson where members were fighting to speak."*
- *"I liked having a real-world research project to participate in during my Microbiology 203 course at National University. I am able to take what I am learning in the lectures and textbook laboratory assignments and apply them to a practical project that may or may not gain useful data from my work in the lab. This enhances learning, makes the course more interesting, and I am able to see the full process of how research is conducted and reported."*





RESULTS

- Vibrio sp., Pseudomonas sp., and Pseudoalteromonas sp. were predominantly present in the ocean water samples. Soil samples species were identified as Pseudomonas sp. and Phaeobacter sp.
- There were increases in student perception of learning across all thematic questions, however, more data is needed to reach statistical significance.

CONCLUSIONS

- Students enrolled in this microbiology class were active research participants and discovered bacterial isolates with antimicrobial-producing potential.
- Students honed their skills in perseverance, critical thinking, communication, and collaboration and gained sought-after skills by doing relevant and current research activities.

BIBLIOGRAPHY

1. A Course-Based Undergraduate Research Experience (CURE) using ocean plastic microbes as a framework that is impactful for both in-person and online course modalities. Education Research International (2023). Ana Barral, Rachel E. Simmons, Marie Boman-Davis, Emelia DeForce, and Jeff S. Bowman.
2. The Small World Initiative™: An Innovative Crowdsourcing Platform for Antibiotics Ana Maria Barral, Huda Makhluf, Nichole A. Broderick, Erika L. Kurt. The FASEB Journal, Volume 30, Issue S1. Presented at the American Society for Biochemistry & Molecular Biology and Experimental Biology, San Diego (2016).
3. Small World Initiative.(n.d.) http://www.smallworldinitiative.org/
4. Undergraduate Research: A Road Map for Meeting Future National Needs and Competing in a World of Change. CUR White Paper No. 1 (2019). Altman, Joanne D.; Chiang, Tsu-Ming; Hamann, Christian S.; Makhluf, Huda; Peterson, Virginia; Orel, Sara E.

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