Undergraduate Student Research Using Biology and Chemistry in a Team Building **Approach**. Khave Zarrabi², Patrick Leary¹, Heidi Porter¹, **Deborah Harbour¹**, Biological Sciences¹, Physical Sciences², College of Southern Nevada, Las Vegas, NV

Abstract

We have developed an integrated undergraduate research program to promote 1^{st} and 2^{nd} year student transfer rates into science disciplines at four-year institutions and graduate school. Our early studies demonstrated that 85% of 100 students rotating through a portion of the program obtained a terminal degree. Here we describe collaboration between a team of four faculty members working with eight students. This project is based on field identification, collection, chemical extraction, and characterization of desert plants. Extracts were tested for antibacterial activity in growth inhibition and biofilm formation. Students rotated through each program phase with a different faculty member but were allowed to concentrate on one aspect of the program, such as characterization of extracts implementing gas-liquid chromatography and mass spectrometry or test the extract effects on biofilm attachment, viability, or cell mass. Students were also allowed to determine the amount of time they wished to contribute to each phase of the program, but all students contributed three semesters of work. Students were assessed by their ability to develop hypotheses, demonstrate laboratory skills, work independently, troubleshoot protocols, and submit manuscripts. Student success was measured by the presentation of their data at scientific meetings, as well as, their pursuit of further scientific research at other institutions. Of the eight students rotating through the four parts of the program, all demonstrated confidence and enthusiasm for their work and are successfully continuing their science majors at universities, two have presented at scientific meetings, one is participating in a summer research program at a university, and two are preparing to apply to graduate schools. We conclude that our results demonstrate undergraduate research programs at two year colleges can be successful in recruiting science majors and researchers.

Introduction

Evidence strongly suggests a benefit of directly involving undergraduates in inquiry based laboratory experiences and research. Although the community college typically has little mechanism for lab based research, we have developed a program to identify students early in their academic career who may have an interest and aptitude in research. The program has had approximately 100 student participants which include firstgeneration college students, at risk students, and under represented minority students. The goal of the program has been to empower students to personalize their own research project through hypothesis testing and characterization of desert plant extracts. None of the 100 students dropped out of the program and approximately 85 completed a terminal degree. In addition, approximately 30 papers have been presented at American Chemical Society regional or national meetings. We have expanded this program to a more diverse program which includes several biological components and allows students at various levels of lab experience to rotate in at various phases. We have documented the experiences of eight students rotating through this program.

Methods

Students begin the program with a discussion of hypothesis testing, safe laboratory practices, procedure and techniques, and documentation. Students may begin at phase 1 or any other phase. Phase 1: Students perform field work in the Mohave desert by collecting plants previously identified medicinal or biological activity, such as evening primrose and rhatany.

Phase 2: Collected plants are returned to the laboratory for analysis by grounding to a powder followed by extraction using various agents. Extracts are dried and reconstituted to known concentrations. Further analysis is performed by characterization of extracts by gas liquid chromatography fractionation.



Phase 3: Students test plant extract fractions for antibacterial activities against Staphlococcus aureus and Staphlococcus epidermidids using disk diffusion, minimum inhibitory concentration, and minimum bactericidal concentration assays.



Phase 4: Plant extracts with identified antibacterial activity are tested for the effects on biofilms using the glass coupon method, drop plate counting, colorimetric spectrophotometry using 96 well plates. The assay is for inhibition of attachment or reduction in overall mass or viable cell count in 48 hour biofilms.





Sample Gas Chromatogram of Hexane Extract of *R. trilobata*

Results:

Assessment

- 1. Analysis and presentation of data
- 2. Ability to direct experimental design and protocol development
- 3. Manuscript preparation
- 4.Presentation at a scientific meeting
- 5.Completion of science degree
- 6.Pursuit of research program
- 7.Enrollment into graduate or professional program.

Follow-up

All eight of the students in this program have completed or are completing a science degree. Two have presented at scientific meetings, four are completing a science degree and three of these are pursuing graduate school, one is pursing medical school, one is in dental school, two have been accepted to competitive summer research programs and are pursuing graduate school.

Conclusions

We have developed a diverse program to attract students into a laboratory experience that encourages presentation of results at scientific, independence and confidence building, critical thought, and pursuit of further scientific experience. Although this program began as a tool to screen desert plants, students interested in other areas of research are able to participate. We believe recruiting students at the beginning of their college education to this type of laboratory work and hypothesis testing will attract more students to science and scientific research. Future efforts will be obtain funding to promote and mature this program, collaborate with 4-year colleges and universities and provide funding for students to attend and present their findings.

References

Suh, Christine. Building Solid Bridges. HHMI Bulletin. Aug 2009. Vol 22:3. 2.Moreno Salazar SF, Verdugo AE, Lopez CC, Martinez EB, Candelas TM, Robles-Zepeda RE. 2008. Activity of Medicinal Plants, Used by Native Populations from Sonora, Mexico, Against Enterophathogenic Bacteria. Pharm Biol. 46:732. 3. Simpson BB. Kramericaea. Article in The Family and Genera of Vascular Plants: Flowering Plants—Eudicots. Springer Verlaag. 2007. New York. 208-212. Jorgensen J, Turnidge J. Susceptibility Test Methods: Dilution and Disk Diffusion Methods. *Manual of Clinical Microbiology*, 9th edition. 2007; Chapter 73: 1152–1172. Center for Biofilm Engineering at Montana State University.

Students were assessed by the following methods: