4TH ANNUAL Small World Initiative Symposium

Small World Initiative
crowdsourcing antibiotic discovery

asm microbe 2017
JUNE 1–5 • NEW ORLEANS

June 1-5, 2017
New Orleans, LA

www.smallworldinitiative.org

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Symposium Schedule

Thursday, June 1, 2017

Small World Initiative Symposium – Convention Center Rm 271

- Graduate & Professional School Expo — 11:00AM – 2:30PM
- Student Scavenger Hunt Virtual Launch — 11:00AM (closes noon Sat.)
- Faculty Tapas Session — 11:00AM – 12:00PM
- Student & Faculty Posters — 12:15PM – 2:15PM
- Keynote – Dr. Jo Handelsman — 2:30PM – 3:15PM
- Group Photo & Announcements — 3:30PM – 3:45PM
- Symposium Awards — 4:00PM – 4:30PM

ASM Microbe

- Registration for ASM Microbe — 7:00AM – 8:00PM
- Opening Session — 5:00PM – 6:45PM
- Opening Reception — 6:45PM – 8:00PM

Friday, June 2, 2017

- SWI Student & Faculty Meet & Greet — TBD
- Informal Dinner Gathering — Place/price TBD

Saturday, June 3, 2017

- Meet the Experts: Todd Kelson (SWI) "How to Engage Undergraduates in Discovery-Based Learning" — 7:30AM – 8:30AM
- ASM Microbe Keynote Address — 6:15PM – 7:15PM

SWI Leadership

From right to left

Erika Kurt, Executive Director

Jo Handelsman, Founder

Nichole Broderick, Program Director

Symposium Organizing Committee

Mustafa Morsy (University of West Alabama), Chair

Todd Kelson (Brigham Young University – Idaho)

Huda Makhluf (National University)

Betsy Roberts (Southern Connecticut State University)

Misty Thomas (North Carolina A&T State University)

About the Small World Initiative

The Small World Initiative™ (SWI) is an innovative program that inspires and retains students in the sciences while addressing one of the most pressing global health challenges of our century – antimicrobial resistance. SWI centers around an introductory biology course in which students perform hands-on field and laboratory research on soil samples in the hunt for new antibiotics. Through a series of student-driven experiments, students collect soil samples, isolate diverse bacteria, test their bacteria against clinically-relevant microorganisms, and characterize those showing inhibitory activity. This is particularly relevant as over two thirds of antibiotics come from soil bacteria or fungi.

SWI's novel approach harnesses the power of active learning to achieve both educational and scientific goals and provides a unique and sustainable platform to replenish the antibiotic pipeline by identifying suitable candidates for testing. Over just four years, SWI has grown rapidly to include 185 participating schools across 37 US states, Puerto Rico, and 11 additional countries – Belize, Canada, India, Iraq, Ireland, Jordan, Malaysia, Nigeria, the Philippines, Spain, and the UK, and has impacted more than 10,000 students. This summer, we will include two new countries – Australia and Colombia, and instructors from more than 50 new schools will be joining our community.

Please visit www.smallworldinitiative.org to learn how to get involved or support us.

Twitter: @Team_SWI

Message from SWI's Executive Director

Dear SWI Community,

This has been another exciting year for the Small World Initiative™ (SWI), and we reached a number of key milestones! I want to extend my sincere thanks to our Committee Chairs – Drs. Debra Davis, Hans Wildschutte, Kristen Butela, Mustafa Morsy, Paula Soneral, and Preston Garcia – for all of their hard work this year, which is the backbone of our collaborative initiative.

Key Milestones Reached

Fast Growth – Since its inception in 2012, SWI has grown rapidly:

- 2012-2013, Yale University
- 2013-2014, 30 Undergraduate Institutions in the US
- 2014-2015, 60 Undergraduate Institutions in 5 Countries
- 2015-2016, 98 Undergraduate Institutions in 9 Countries, Pilot High School Program
- 2016-2017, 185 Undergraduate Institutions and High Schools in 12 Countries
- To date, we have impacted more than 10,000 students and 250 instructors.

Recognition – Hundreds of our students and partner instructors have presented their original research at major conferences around the world and even on Capitol Hill. Recently, Dr. Barb Murdoch was invited to speak about the Small World Initiative at the United Nations!

Student Impact – Following the 2016 Journal of Microbiology & Biology Education (JMBE) article supporting our educational impact, Dr. Nichole Broderick is leading a more in-depth study to evaluate the impact of authentic research experiences through SWI.

Opportunities – We continue to develop opportunities for students and faculty that further our pedagogical and scientific goals. In particular, we have established three new awards to recognize scientific discovery, leadership, and pedagogical innovation. These add to our previously established awards for scientific persistence and excellence in mentorship.

The Do Something About Antibiotics Challenge – We teamed up with The Centers for Disease Control & Prevention (CDC) to challenge students to do something about the antibiotic crisis in recognition of the CDC's 9th Annual Get Smart About Antibiotics Week. The fabulous entries are posted on our website: http://www.smallworldinitiative.org/do-something-challenge.

Material Development – We finalized new biosafety materials and published the 4th edition of our course materials spring 2017.

On the Horizon

School Expansion – Over the next 12 months, our network will expand to more than 235 undergraduate institutions and high schools and will include two new countries – Australia and Colombia. The majority of instructors from these new institutions will be trained at the University of Connecticut this July.

New Database – We are planning a new soil database that will be more user friendly and make it easier to analyze aggregate data.

Curriculum Development – We are developing new modules that expand beyond our introductory microbiology course.
I am looking forward to continuing on this journey using innovative strategies to inspire the next generation of scientists, increase scientific literacy, and confront the antibiotic crisis head on.

All my best,

Erika Kurt
President & Executive Director

Keynote Speaker

Dr. Jo Handelsman stands out as a change maker, visionary, and maverick in science and education. Her scientific research focuses on studying the diversity of microbes in soil as well as microbial communities and interactions in soil and insect gut. She was one of the pioneers of metagenomics, a functional approach to studying the genetic diversity of unculturable bacteria in environmental samples. In addition, Dr. Handelsman is known internationally for her efforts to improve science education and participation of women and minorities in science and co-founded the Wisconsin Program for Scientific Teaching, the Yale Center for Scientific Teaching, and the National Academies Summer Institute on Undergraduate Education. While at Yale University in 2012, she started the Small World Initiative (SWI) with the goal of strengthening STEM education, addressing the antibiotic crisis, and sharing her passion for soil microbes. Dr. Handelsman initially introduced the concept of SWI through an undergraduate course titled "From Microbes to Molecules." Her vision transformed the six-student introductory biology course into the international collaboration the program has become today.

Dr. Handelsman is the outgoing Associate Director for Science in the White House Office of Science and Technology Policy (OSTP), appointed by President Obama and confirmed by the Senate in June of 2014, and helped advise the President on the implications of science for the Nation, ways in which science can inform US policy, and Federal efforts in support of scientific research. Starting February 2017, she began leading the Wisconsin Institute for Discovery at the University of Wisconsin-Madison (UW). Prior to joining OSTP, she was a Howard Hughes Medical Institute Professor and Frederick Phineas Rose Professor in the Department of Molecular, Cellular, and Developmental Biology at Yale University.

Dr. Handelsman received her Ph.D. in Molecular Biology from UW in 1984, and she served on UW's faculty from 1985 until moving to Yale in 2010. Her leadership has led to her appointment as the first President of the Rosalind Franklin Society; her appointment as President of the American Society for Microbiology in 2013; her service on the National Academies' panel that wrote the 2006 report, "Beyond Bias and Barriers: Fulfilling the Potential of Women in Academic Science and Engineering;" her role as co-chair of the PCAST working group that developed the 2012 report, “Engage to Excel,” which contained recommendations to the President to strengthen STEM education to meet the workforce needs of the next decade in the United States; and her selection by President Obama to receive the Presidential Award for Excellence in Science, Mathematics, and Engineering Mentoring.

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Poster Session 2

Abstracts

1. Antibiotic Resistance Awareness Day: Student Participation Yields Antibiotic Producers

Durr Ana Gatlin, Meagan Moore, and Lyndsey Palmer
Baton Rouge Community College, Baton Rouge, LA

Get Smart about Antibiotics Week promoted by the Center for Disease Control is meant to bring awareness of the global concern of antibiotic resistant bacteria and the overuse and incorrect use of antibiotics to the public. Along with the classmates in our Introductory Microbiology course, we set out to reach as many students, on the Baton Rouge Community College campus, to educate them in this global concern. We transformed the Small World Initiative techniques to employ a citizens' science project that allowed students to be involved in collecting potential antibiotic producers. Students were given the freedom to collect samples of their choice. Samples were from the campus soil, personal belongings, and inanimate objects. Overall, 184 students, representing 21 degree programs, were involved in the collection process and 245 samples were collected. We then screened the samples for antibiotic producers against *S. aureus*. A total of forty isolates showed some level of inhibition; 24 of those showed significant zones of inhibition. These 24 samples were then screened for antibiotic production against all ESKAPE pathogens and sequenced for identification. Students who were involved in the collection process were notified if they had isolated a producer and will be kept informed as this project moves forward. This project yielded multiple antibiotic producers that will be further studied. Additionally, it exposed the BRCC campus to the idea of citizens' science projects that will be used in upcoming events.

2. Isolation and Characterization of Antibiotic Bacteria from a Soil Sample Collected at Florida Atlantic University Campus

Jayson Burkhardt, Noah Kaplan, and Diane Baronas-Lowell
Department of Biological Science, Florida Atlantic University, Boca Raton, FL

Antibiotic resistance has become an increasingly prevalent threat, with new bacteria gaining resistance to last resort drugs currently available, such as colistin. The recent discovery of the transferable colistin-resistance gene, *mcr-1*, has compounded the dire need to discover new antibiotics (Liu, YY et al., Lancet Infect Dis. 2016 Feb;16(2):161-8). To help combat this growing public threat, many students from around the world are taking part in isolating and identifying new antibiotic-producing bacteria from soil as part of the global Small World Initiative (SWI). Here we describe the results of some of our work in these efforts as part of the SWI labs at Florida Atlantic University (FAU).

A soil sample was taken at FAU campus in Boca Raton, FL. Thirty-two bacterial patches were isolated from the sample and were tested for antimicrobial activity against four safe relatives of ESKAPE pathogens. Three of the active bacterial isolates were found to have broad spectrum activities when tested against all nine safe relatives. These antimicrobial activities were dependent on the conditions under which the three bacterial isolates were grown.

Sequencing of the 16S rRNA and subsequent BLAST searches have identified two of these three isolates as species of *Rheinheimera* and *Pseudomonas*. The three isolates were subsequently characterized through biochemical assays and morphological studies. One of these isolates appears to interact with one of the relatives, *Acinetobacter baylyi*, and forms a filamentous outer layer surrounding the colonies. Finally, resistance to common antibiotics has been demonstrated for the three isolates. Our data illustrate the diversity of microbes in South Florida soil and contribute to the goal of finding new antibiotic-producing bacteria.

3. Genus Stenotrophomonas Produces Zones of Inhibition Against 4 Different ESKAPE Pathogens

Kellie Brockbank, Tanya Beach, and Todd L. Kelson

Biology Department, Brigham Young University Idaho, Rexburg, ID

The Small World Initiative program was implemented at Brigham Young University-Idaho as a means to study the enormous variety of microorganisms found in the soil and their potential for producing antimicrobial compounds. On the south side of BYU-Idaho campus, there is an apple orchard; we collected soil from the A horizon in that rich, fruit producing ground, in the middle of a frigid winter (soil temperature was -2°C on the day of collection), under 2 feet of snow. Soil bacteria were incubated on Nutrient Agar and 10% Tripticase Soy Agar (TSA) for 7 days at 20°C. After incubation, we isolated a variety of colonies that had different morphological characteristics, and transferred them to a master plate on 50% TSA agar. These colonies were then tested against 4 of the safe relatives of ESKAPE pathogens (*Enterococcus faecium*, *Staphylococcus aureus*, *Klebsiella pneumoniae* and *Acinetobacter baumannii*). One colony produced a zone of clearing when incubated with all 4 safe relatives at 28°C for 48 hours. This was later confirmed on the proof plate. 16s rRNA sequencing demonstrated a high identity (>99%) with the genus *Stenotrophomonas*.

4. The Threat of Antibiotic Resistance

Marisa Carman and Claudia Carvalho
Department of Biological Sciences, Fort Hays State University

Over the past decade, the threat of bacteria becoming resistant to antibiotics has been increasing. Bacteria have been overexposed to antibiotics, which have allowed them to adapt to the different effects of antibiotics. ESKAPE pathogens are nosocomial pathogens with growing resistance. The six ESKAPE pathogens are *Enterococcus faecium*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Acinetobacter baumannii*, *Pseudomonas aeruginosa*, and *Enterobacter* species (Hicksa, et al., 2013). Small World Initiative at FHSU is dedicated to searching for novel antimicrobial properties by studying microbes present in soil samples from chosen locations around Hays, Kansas. The soil samples were diluted and plated on BHI agar plate. Fifteen isolates were chosen based on morphology and allowed to grow on BHI, and then tested against the ESKAPE relatives. Three isolates that presented a zone of inhibition were chosen for purification and characterization. From the streak plate, a small bit of the colonies was put in a tube along with primers, water, and a master mix of nucleotides and enzymes. The tubes were placed in a PCR thermocycler, and the 16s RNA gene was isolated from each isolate. Clean PCR products were then sent to DNA sequencing facility for genus identification. Characteristics of the organisms were narrowed down by running several biochemical tests as well as extracting the organic material of the isolate. If a new bacterium is found to potentially inhibit the growth of ESKAPE relatives, the bacterium could possibly be used to create a new antibiotic.

5. Small World Initiative: What's in Your Backyard?

JP Conly, Jonathan Waldron, Hanna Krochmal, Juliann Downing, and Huda A. Makhluf
College of Letters and Sciences, National University, La Jolla, CA

The goal of the SWI class project has been to find new bacteria in Southern California that could be used as antibiotic-producing isolates in combatting the international antibiotic crisis. Multiple soil samples were collected from local communities. Standard protocols were employed to isolate distinct types of bacterial strains. Antimicrobial testing was conducted using the Kirby-Bauer method. Gram positive *S. aureus* and gram negative *E. coli* were selected to study antimicrobial efficacy. Two isolates showed promising antimicrobial properties. The first, identified as WH4-1, was obtained from a soil sample from a tomato garden in a quasi- Mediterranean climate. WH4-1 showed large zones of inhibition against both *S. aureus* and *E. coli*. The second was identified as RA2, tested positive against *S. aureus* only, and was found in a soil sample from an arid region with a desert climate known as Ocotillo Wells. These positive strains were

further characterized. DNA was extracted, amplified by PCR, and sequenced using 16S forward and reverse primers. WH4-1 was identified as a gram-positive strain of *Bacillus pumilus* while RA2 was identified as a gram-negative strain of *Pseudomonas cuatrocienegasensis*. Comparing these findings to previous SWI class results indicated that *Bacillus pumilus* was a recurrent positive isolate found abundantly in Southern California soil samples; however, this particular strain, WH4-1, may be unique given its inhibitory effects against *E. coli*. *Pseudomonas cuatrocienegasensis* is the first gram negative isolate identified by our class cohort from a desert region unique to Ocotillo Wells.

6. Finding Antibiotic Producing Bacteria in Terrabonne Bay

Jarron Courville and Phillip Mooney
Baton Rouge Community College, Baton Rouge, LA

As a part of the Small World Initiative, we collected samples in Terrebonne Bay which is a marine environment off the coast of south Louisiana. A trawl net was used to retrieve samples from the bottom of the bay which provided diverse specimens to screen for antibiotic producing bacteria. The specimen chosen for our screening was sea grass. We chose our bacteria after preliminary patch-patch testing for zones of inhibition against: *S. aureus*, P. aeruginosa, and *E. coli*. To determine the species, we conducted stains and metabolic tests including: gram, capsule, and spore stains, and sulfate reduction, oxygen requirement, starch hydrolysis, blood hemolysis, carbohydrate fermentation, and IMViCs. Identification was confirmed by 16S rRNA sequencing. The first bacterium was found to be *Shewanella spongiae*, it did not produce zones of inhibition against the tested ESKAPE pathogens. The other bacterium was genetically similar to both *Bacillus safensis*, and *Bacillus pumilus* and produced zones of inhibition. The *Shewanella spongiae* was thought to produce antibiotics because it had a zone of inhibition against a contaminant in the original master plate. The *Bacillus sp.* isolated produced antibiotics; therefore, it is an ideal candidate for further research. Searching for antibiotic producing bacteria in

the soil is a promising solution to the dwindling of medical antibiotics. Both isolates showed promising attributes and can lead to more research opportunities.

7. Isolation and Cultural Characteristics of a Pigment-producing *Streptomyces spp*. MA-64

Andrew Dalrymple and Alice Lee
North Carolina State University, Raleigh, NC

Natural compounds isolated from microorganisms are set to play an increasingly important role in modern industrial and commercial applications. Organic dyes, antibiotics, industrial enzymes and other biological compounds can be a source of cheaper and cleaner substitutes for modern chemicals. Moreover, the advances in biotechnology will allow us to engineer these molecules and produce them in an efficient manner. Soil bacteria, such as those of the genera *Streptomyces* have already exhibited promise as major producers of antibiotics, but also of other possibly important secondary metabolites, such as pigments. A novel *Streptomyces spp*. MA64 isolated from loam soil on local hiking trails may be a producer of antibiotics and possibly of other industrially or commercially significant secondary metabolites. In screens for antimicrobial activity, this isolate produced zones of inhibition when tested against *Escherichia coli* and *Bacillus subtilis.* This novel *Streptomyces* isolate also produces a vibrant pink pigment. Optimization of growth conditions using various sugar and protein-based media as well as different incubation periods were performed. The isolate shows strong pigmentation when cultured on R2A agar at 23-25°C for 48 or more hours, but no pigmentation was observed when cultured in R2A broth. The isolate will grow, but not pigment, on other types of solid media. Growth under various acidic and basic conditions of R2A broth were conducted. Future experiments will include organic extraction of the pigment, evaluation of its feasibility as an organic dye, and analysis of antimicrobial activity of the pigment.

8. Investigating Antibiotic Producing Bacteria Isolated in a non-STEM Major SWI Course

Dallas C. DeSalvo
Wingate University, Wingate, NC

Overuse of antibiotics has resulted in the increased prevalence of multi-drug resistant strains of bacteria, including the ESKAPE pathogens - the primary causative agents of hospital associated infections (HAIs), and the fourth leading cause of death in the United States. The concurrent decline in effective antibiotics is a global crisis that the Small World Initiative hopes to address using crowdsourcing to quickly identify novel antibiotic producing bacteria to combat these resistant strains. Soil samples were collected from sites in Monroe, and Wingate, NC during a non-STEM major SWI course at Wingate University. Two isolates, 63 and BHR, were of particular interest due to their peculiar morphology (a suspected mixed culture), and ability to inhibit ESKAPE pathogens. In this study, both isolates were recovered from frozen, with the goal of confirming their morphological and biochemical characteristics, determining their identity using the 16S rRNA gene sequence, and exploring their antibiotic producing potential by re-screening them against ESKAPE pathogen safe relatives. Isolate 63 was mixed and contained two pigmented bacteria, a purple isolate (63P), and a yellow isolate (63Y). The aerobic, mesophilic, non-fermenting isolates have been preliminarily identified as *Janthinobacterium sp.* (63P), *Flavobacterium sp.* (63Y), and *Bacillus aymloliquefaciens* (BHR). Morphological and biochemical characteristics confirmed the genus identification of these isolates. The potential of these soil bacteria to produce novel antibiotics that are capable of inhibiting ESKAPE pathogens is significant. Species of *B. aymloliquefaciens* and *Janthinobacterium sp.* have been shown to produce antimicrobial secondary metabolites that are effective against phytopathogenic fungi and bacteria, and pathogenic Gram negative bacteria, respectively. *Flavobacterium* species (including our isolate) have not yet been shown to inhibit any of these pathogens. BHR was the only isolate capable of inhibiting ESKAPE pathogen safe relatives.

9. Unexplored Ecological Niches of the Canadian Arctic as Potential Hotspots for Natural Antibiotic Bioprospecting

Owen Dunkley, Emma Hignett, Mathieu Mancini, Lyle Whyte, and Samantha Gruenheid
McGill University, Montreal, Canada

Soil hosts a wide variety and large biomass of organisms in constant competition, leading to the evolutionary development of secondary metabolites including some antibiotics. As novel antibiotics have gradually become more difficult to find in regularly studied habitats, bioprospecting efforts have begun to shift focus to extreme, unique or remote ecological environments. In this study, students from McGill University tested whether antibiotic-producing bacteria could be isolated from soil collected either at the McGill Arctic Research Station on Expedition Fjord, Nunavut or from a variety of locations within the greater Montreal area. Using culture methods, isolates were screened for their inhibition of relatives of common nosocomial ESKAPE pathogens and *Bacillus subtilis*. 107 antibiotic activity-positive isolates of which 47 came from Arctic soil were identified using 16S rRNA gene sequencing along with a number of biochemical tests. Phylogenetic analyses indicated that the antibiotic-producing bacteria from both geographic locations included a range of predominantly Gram-positive Actinobacteria and Firmicutes, in addition to a short list of Proteobacteria. Alongside further optimized isolation from various high Arctic habitats, full genome sequencing and organic extractions will help characterize the active antimicrobial chemicals to definitively establish a geographical influence on discovery.

10. Citizen Science and Antibiotic Discovery

Ethan Drury[1], Gary Rowley[1], Elena Nardi[2], and Laura Bowater[3]
University of East Anglia, Norwich, United Kingdom
[1] School of Biological Sciences

[2] School of Education and Lifelong Learning
[3] The Norwich Medical School

Background: Bacteria, including pathogenic bacteria, are developing antibiotic resistance, allowing them to survive therapeutic levels of an antibiotic that would have killed them. As global antibiotic use increases, the incidence of antibiotic resistance increases also. It is clear that more resources are required to tackle the growing threat associated with the emergence of antibiotic resistant strains of bacteria. We identified two avenues to tackle the future of antibiotic resistance: firstly, to preserve the current antibiotics that we have available through engagement with significant stakeholders including the public; and, secondly, by contributing to the drug discovery pipeline. The recent discovery of Teixobactin, a novel antibiotic, suggests that the soil may contain undiscovered bacteria and potentially be a source of novel antibiotics. To achieve these aims, we have developed a citizen science project design to allow us to merge education and science research.

Methods: Members of the public, present in two U.K forests, collected 305 soil samples that were screened by growing on LB agar and looking for zones of microbial inhibition. 233 antibiotic producing bacteria were identified. These were tested against Gram negative and Gram positive indicator strains. 62 of the 233 colonies showed some inhibitory action against at least one of four indicator strains. 11 colonies inhibited Gram negative Salmonella typhimurium, 6 colonies inhibited both Gram positive *Bacillus subtilis* and Staphylococcus epidermis. These 17 colonies were sent for 16S rDNA sequencing. Two of these colonies seem to inhibit *Salmonella typhimurium* DT104, a virulent pathogen for humans and animals with resistance to ampicillin, chloramphenicol, streptomycin, sulfonamides, and tetracycline. As well as screening the soil samples, we conducted semi-structured interviews with 23 of the participants. The interviews aimed to understand public perceptions of antibiotics and antibiotic resistance in order to identify key themes to be used to influence future campaigns and future behavior regarding responsible use of antibiotics. We are currently conducting discourse analysis of the interviews, samples of which will be available by the time of the conference. We aim to identify potential behavioral changes through the analysis of medium term participant engagement through analysis of social media interactions and long term participant engagement through analysis of journals produced by participants. We conjecture that engaging the public in the antibiotic discovery pipeline whilst understanding public perceptions of antibiotics and antibiotic resistance will, in turn, encourage behavior which will preserve the current antibiotics and encourage interest in the discovery of novel antibiotics. Combined, these will help in the process of tackling the emerging threat of antibiotic resistance.

11. The Isolation and Identification of a Potential Novel Antibiotic Producer from Arctic Soil

Alicia Jia, Wally Wennerberg, Annie Bernier, Lyle Whyte, and Samantha Gruenheid
McGill University, Montreal, Canada

The rapid rise of antibiotic resistance has led to its establishment as a global health crisis, which the Small World Initiative is attempting to combat by crowdsourcing the early stages of antibiotic discovery to address the urgent need for novel antibiotics. The discovery of novel antibiotics has often stemmed from the investigation of microbes which reside in soil, and their natural production of antibiotics in response to competition for resources. In this experiment, soil from the McGill Arctic Research Station in Nunavut, Canada, was used to investigate potential antibiotic producers against safe relatives of the ESKAPE pathogens. The arctic soil sample was serially diluted and patched onto different media to produce master plates in order to isolate bacterial colonies of interest. The arctic soil isolates were then screened for antibiotic activity against the ESKAPE pathogen relatives. One isolate, C5D23, was found to have positive antibiotic activity against *Bacillus subtilis*, used by the Small World Initiative as a safe relative of *Enterococcus faecium*. To identify C5D23, 16S rRNA sequencing, differential staining techniques, and a variety of biochemical tests were performed. The results from BLAST, the Gram and spore stains, and biochemical investigations, support the conclusion that C5D23 is of the Nocardia genus, possibly *Nocardia coeliaca*, although more experiments such as whole-genome sequencing would be needed to conclusively prove this.

12. Detailed Phenotyping and Genomic Analyses of Antibiotic-Producing Soil Microbes Generated from the Small World Initiative at McGill University

Emma Hignett[1], Julie Jeukens[2], Tyler Cannon[1], Jean-Guillaume Emond-Rheault[2], Jérémie Hamel[2], Brian Boyle[2], Iréna Kuakvica-Ibrulj[2], Lyle Whyte[1], Roger Lévesque[2], and Samantha Gruenheid[1]
[1] McGill University, Montreal, Canada
[2] University of Laval, Quebec City, Canada

Fueled by the overuse of antibiotics and the increasing danger of ESKAPE pathogens, antibiotic resistance is an impending public health crisis. However, little is being done to develop novel antibiotics. The Small World Initiative (SWI) is a multi-institutional, collaborative program that aims to solve this problem by looking for novel antibiotics from soil microbes. At McGill University, the first Canadian institution to participate in the SWI, 347 students have cultured and isolated soil microbes from the greater Montreal area and the McGill Arctic Research Station. In the past three years, over 7,000 cultures have been isolated and over 500 have shown antibiotic activity. More than 300 of the antibiotic-producing isolates were further characterized through microbiological, molecular, and biochemical methods. In the summer of 2016, 13 isolates were prioritized for detailed characterization based on their antibiotic activity and presumptive identity from 16S rRNA sequencing results. Further characterization of these isolates included organic extractions, full-genome analyses, and comprehensive antibiotic activity screens.

13. Isolation and Characterization of Two Antibiotic-Producing Bacteria from Montreal Soil with Activity Against Gram-negative and Gram-positive Bacteria

Jennifer Hitti, William Jogia, Jasmin Chahal, and Samantha Gruenheid
McGill University, Montreal, Canada

Antibiotic resistance has become an important threat to global health. As multidrug resistant bacteria become more prevalent, many people may die from previously curable diseases unless new antibiotics are discovered. Soil is an ideal environment from which to discover novel antibiotics due to the large density of competing microorganisms. In this experiment, bacteria were isolated from soil collected on the McGill University campus, in Montreal, Quebec. Forty-eight bacterial isolates were then tested for antibiotic activity against safe ESKAPE pathogen relatives. As expected, many isolates from the soil showed antibiotic activity: ten out of the forty-eight isolates (21%) exhibited antibiotic activity against one or more ESKAPE relatives. Two of these antibiotic-producing isolates, with activity against Gram-negative and Gram-positive ESKAPE relatives, were further characterized using microscopy, biochemical and molecular assays. Using 16S rRNA sequencing, one of the isolates was determined to be from the Pseudomonas genus, and the other is suspected to be from the Shigella genus. Further research, such as full genome sequencing and chemical extraction analysis, is needed to identify the acting antibiotic metabolites produced by each of these isolates, and to determine their potential for clinical use.

14. Two Bacterial Soil Isolates from the McGill University Campus Demonstrate Antimicrobial Activity against *Streptococcus epidermidis*

Bushra Khan, Vilany Le, Junbin Li, and Samantha Gruenheid
McGill University, Montreal, Canada

Due to the rise of antimicrobial resistance, ESKAPE pathogens are now a major threat to global public health. Despite the increased risk of serious nosocomial infections, the pipeline for

the development of new antimicrobials is virtually empty. The Small World Initiative (SWI) aims to crowdsource antibiotic discovery to combat the current antimicrobial resistance crisis. In this study, soil isolates from the McGill University campus were successfully obtained and screened for antimicrobial production against tester strains similar to the ESKAPE pathogens using patch/patch screens. Two isolates demonstrated antimicrobial production against Streptococcus epidermidis. These two antimicrobial producing isolates were further identified as *Arthrobacter* and a *viridans Streptococcus* through 16S rRNA gene sequencing, microbiological and biochemical testing. Further purification of the antimicrobial compound active against *S. epidermidis* is needed. Overall, we show that soil microbes can be screened for antimicrobial production and used to identify potential sources of novel antimicrobials.

15. Investigation of Antibiotic Resistance Producing Organisms from the Soils of North Carolina: Perspectives from a STEM Early College Student

Mariama Ibrahim, Jewel Tinsley, and Misty Thomas
Department of Biology, North Carolina A&T State University, Greensboro, NC

The antibiotic resistance crisis has caused conversation and controversy across the world between some scientist and clinicians believing that we are currently in the midst of it (1) and others believing that it is a distant and theoretical problem (2). The antibiotic resistance crisis is the theory that microbes are becoming resistant to antibiotics quicker, causing antibiotics to be ineffective faster than the rate new ones can be developed. As part of the Small World Initiative, we played a role by collecting a soil sample from the University Farm owned by North Carolina Agricultural and Technical State University. The sample was taken from a very diverse and nutrient rich area where cows had previously grazed and small shrubs were located. After testing our sample against two ESKAPE relatives;

Pseudomonas putida and *Mycobacterium smegmatis* we were unable to find a producer. We did continue with one microorganism from another group and after 16S sequencing we concluded that it was potentially *Bacillus pumilus*. Biochemical tests and staining were used to identify this organism as a gram-positive bacterium and it was concluded based on the results that was seen from our various biochemical test such as MacConkey and Phenol Alcohol Agar. As a high school student in the STEM Early College Program at North Carolina A&T, this program has had a huge impact on me, especially being involved in microbiological research. We were given a better understanding of the world of microbiology and also realize the impact and given the chance to play a role in helping the antibiotic crisis, an opportunity that few high school students are able to have as part of their education.

16. Antibiotic Discovery Across Saline Gradient of the Simpson Wildlife Sanctuary

Riley King, Mara DeLuca, and Mustafa Morsy
Department of Biological and Environmental Sciences, University of West Alabama, Livingston, AL

Salt works in Stimpson Wildlife Sanctuary in Clarke County, Alabama were an indispensable salt mine to the Confederacy during the Civil War. The area is characterized by the presence of a gradient of salt, ranging from fresh water to water with up to 500mM Total Dissolved Salts (TDS). The varying concentrations of salt across the land provides an opportunity to explore the bacterial diversity and the presence of antibiotics producing bacteria in response to salt stress. The goals of this study are: 1) to compare the effect of different salt concentrations on the diversity of antibiotic producing bacteria found in the soil of Stimpson Wildlife Sanctuary and 2) to examine the diversity of bacteria found within the varying salt concentrations. We have collected soil samples from the saline gradient of the Simpson Wild Life Sanctuary, ranging from 0-500mm TDS. Soil bacteria was isolated by plating serial dilutions of soil extracts onto various bacterial media and grown at two different temperatures, to ensure recovery of the most bacteria possible. Nearly 3,000 bacterial colonies have been isolated and arrayed in 96 well plates. Currently, we have identified inhibition zones, and results show that in the presence of higher concentrations of salt more antibiotic producing bacteria. Various species of *Enterococcus*, *Serratia*, and *Citrobacter* bacteria have been identified using DNA sequences extracted from unknown bacteria by PCR amplification, DNA extraction, and DNA sequencing.

17. Investigating the Antibiotic Activity of a Swamp-dwelling *Chromobacterium* Species

Hannah Guilani, Emily McClure, Patricia Rossi, and Nichole Broderick
Department of Molecular and Cell Biology, University of Connecticut, Storrs, CT

Throughout the course of the semester, a wide range of experiments and techniques were carried out that allowed for the isolation and testing of possible antibiotic producing bacteria from soil against ESKAPE pathogen relatives. After assessing the activity of all 46 isolates across LB and PDA media types, two isolates (HG PDA-A and HG PDA-G) were selected for further testing. These two isolates were biochemically characterized and identified using 16S rRNA sequencing technology, as well as extracted for organic antibiotic compounds. It was found that the isolate PDA-A is a member of the *Chromobacterium* species, and a possible producer of the biological pigment violacein. Violacein is a chemical compound with known anti-bacterial, anti-fungal, and possibly anti-cancerous properties.

18. More Valuable Than Gold - Prospecting for Novel Antibiotics in the Greater Yellowstone Ecosystem

Natalie Macbeth, Robert Coffman, and Todd L. Kelson
Biology Department, Brigham Young University Idaho, Rexburg, ID

In pursuit of unearthing bacteria producing novel antibiotics, we collected a soil sample on the Brigham Young University-Idaho campus from the top 2-8 inches of cultivated landscape. Bacteria were isolated (using serial dilutions) by spreading them on Nutrient and 10% Trypticase Soy Agar (TSA) plates. Thirty-two distinct colonies were transferred to Emerson and Nutrient agar creating master plates used for the duration of the 8-week experiment. Each colony was tested for antibiotic production by transferring it to plates inoculated with ESKAPE safe relatives, noting zones of clearance. Three colonies showed zones for *Bacillus subtilis* (Gram positive), *Acinetobacter baylyi* (Gram negative), and *Pseudomonas putida* (Gram negative) when grown on Luria Broth (LB) and Emerson agar after 24 hours and 50% TSA after 48 hours when incubated at 28 C. A streak plate was used to isolate one of the newly discovered antibiotic-producing bacteria for identification by sequencing the 16s rDNA and utilizing BLAST analysis. The isolate was found to be of the Bacillus genus.

19. Identification and Toxicity Testing of Antibiotic-Producing Bacterial Strains at Bethel University

Hannah Manion, Alyssa Spofford, and Paula Soneral
Bethel University, St. Paul, MN

Antibiotic resistance is a global crisis, due in part to the decrease in research and development of novel antibiotics in spite of the increasing occurrence of resistant microorganisms. In conjunction with the Small World Initiative, the purpose of this study was to search for and catalog novel antibiotic-producing soil microbes from Bethel University's campus ecosystems. Over 100 samples of viable bacteria were analyzed from 31 unique locations after cryopreservation. Each bacterial strain was then screened for antibiotic activity against gram positive *Micrococcus luteus* and gram negative *Escherichia coli* tester strains. Antibiotic-secreting bacteria were identified through PCR amplification of the 16s rRNA gene, DNA sequencing, and BLAST

analysis. Bacterial strains showing zones of inhibition against at least one tester strain were tested for their ability to produce secondary metabolites with toxicity to eukaryotic cells, where supernatants of overnight cultures were incubated with *Elodea canadensis* for 24 hours, then scored on a 5-point scale from no necrosis to complete necrosis of the leaves. Out of 113 strains, 65 (57.5%) produced zones of inhibition; 30 against *M. luteus* (26.5%), and 11 against *E. coli* (9.7%). 24 strains produced zones of inhibition against both tester strains, suggesting broad-spectrum of activity (21.2%). The BLAST analysis identified 60% of the strains to be *Bacillus*, 13% *Pseudomonas*, and the remaining 27% as *Staphylococcus, Pantoea, Terribacillus, Burkholderia, Enterobacter,* and *Acinetobacter.* Toxicity data indicated that, out of 66 secondary metabolite-producing bacteria, 21 were not toxic to *E. canadensis* (31.8%), 41 caused partial necrosis (62.1%), and 4 caused nearly complete necrosis (6.1%). Although no novel antibiotic-producing bacteria were discovered, this study illustrates the development of robust methods for toxicity testing against eukaryotic cells, laying groundwork for future antibiotic research.

20. Antibiotic Producing Proteobacteria and Actinobacteria from Monroe, NC Soil

Kaylan H. McCain and Debra A. Davis
Wingate University, Wingate, NC

A sandy clay loam soil sample from Monroe, North Carolina, was hypothesized to contain a diverse population of antibiotic producing bacteria. The soil sample was collected, and Potato Dextrose Agar (PDA) was used to isolate antibiotic producing bacteria, which were purified, characterized morphologically, and their biochemical capabilities and requirements for growth determined. Of the 19 morphologically varied colonies that were isolated and selected from the soil, 52.6% exhibited antibiotic producing capabilities. Plate assays were used to screen the selected isolates potential to inhibit the growth of safe relatives to the ESKAPE pathogens and their susceptibility to commercial antibiotics. All chosen isolates were effective against multiple ESKAPE pathogen safe relatives (*Enterococcus raffinosus*, *Staphylococcus cohnii*, *Escherichia coli*, *Acinetobacter baylyi*, *Pseudomonas putida*, *Enterobacter aerogenes*, and *Bacillus subtilis*). Isolate 24, preliminarily identified as *Pantoea vagans*, was the only isolate found to be capable of inhibiting the growth of all 7 ESKAPE safe relatives. The antibiotics were crudely extracted from the isolates, and only extracts from three isolates were effective against Gram positive safe relatives. Though morphologically and biochemically diverse, preliminary identification of these isolates obtained via 16S rRNA gene sequencing of their extracted genomic DNA indicated that only 2 Phyla were represented – the Proteobacteria and Actinobacteria. The Proteobacteria species included the Gammaproteobacteria, *Pantoea vagans*, and the Betaproteobacteria, *Achromobacter xylosoxidans*, and *Achromobacter marplatensis.* The Actinobacteria were mainly of the order Streptomycetales, however isolate 7P was preliminarily identified as the genus Arthobacter of the order Micrococcales. Isolates 7P, 7W, 15, and 24 have not yet been fully studied for their antibiotic producing capabilities and have the potential to be novel antibiotic producing bacteria. In conclusion, while this backyard soil was hypothesized to be widely diverse, it contained only culturable antibiotic producing bacteria from two phyla. These Monroe, NC, isolates show tremendous promise and will be further investigated.

21. Screening for Type III Secretion System Inhibitors

Samir Nacer, Kevin Lujan, Kendall Mockridge, Chris Soha, Eugenia Jimenez, and Julie Torruellas Garcia
Nova Southeastern University, Fort Lauderdale, FL

Commonly used antibiotics are becoming less effective since overuse creates a selective pressure for bacteria to become resistant, leading to the formation of “super bugs”. Some of these pathogenic bacteria include *E. coli*, *Salmonella*, *Chlamydia* and

Yersinia species. These species utilize a type III secretion system (T3SS), which are needle-like structures on their surface used to inject host cells with toxins in order to evade our immune system and cause infection. Recently, a new method for testing compounds to determine if they inhibit the *Y. pestis* T3SS was developed by our lab. This method uses a special growth medium called Magnesium Oxalate (MOX) agar, which produces distinct growth characteristics based on the bacteria's ability, or inability, to secrete toxins. The goal of this research was to use this method to screen for antimicrobials produced by soil bacteria that may target T3SSs. Many species of bacteria found in soil produce antimicrobials in order to compete with each other for nutrients and space. Serial dilution plating was used to isolate soil bacteria and each isolate was patched onto MOX agar plates pre-inoculated with *Y. pestis*. After incubation, the areas around each soil isolate were analyzed for the *Y. pestis* growth characteristics associated with blocked T3S or growth inhibition. The soil bacteria that exhibited positive results were tested against ESKAPE pathogen alternatives and identified using 16S rDNA sequencing. Bacillus cereus strain JEM-2 and *Bacillus amyloliquefaciens* strain SSH100-3 were soil isolates identified to have antibacterial activity against *Y. pestis*.

22. Isolation of Soil Microbes to Test Against ESKAPE Relatives for Antimicrobial Properties

Sara Nansel and Claudia Carvalho
Department of Biological Sciences, Fort Hays State University, Hays, KS

Isolation of Soil Microbes to Test Against ESKAPE Relatives for Antimicrobial Properties. The ESKAPE pathogens (*Enterococcus faecium*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Acinetobacter baumannii*, *Pseudomonas aeruginosa*, and Enterobacter species) are a group of bacteria that have developed multiple resistances to antibiotics (Boucher et al.). Antibiotic resistance occurs when bacteria have the capability to adapt, mutate, and multiply in the presence of antibiotics. This presents a worldwide health concern as antibiotics that were commonly used to treat these nosocomial infections are no longer effective. By testing bacteria obtained from soil samples against relatives of the ESKAPE pathogens, the goal is to find new antimicrobial properties that will act against the ESKAPE relatives. As part of the Fort Hays State University chapter of Small World Initiative, microbes were isolated from the soil collected around Hays, KS near an oil well outside of town, the city's compost site, and Big Creek. Thirty isolates were selected based on morphological differences from each site to test against the *ESKAPE* relatives to observe inhibitory effects. After selecting four pure isolates that showed this property, a combination of staining techniques, biochemical testing, as well as genetic analysis were performed for bacterial identification and characterization. All of the isolates were found to be Gram positive organisms of the Bacillus genus. Organic extraction was performed on each isolate to isolate the inhibitory component. Each pure extract was then retested against the bacterial lawns of the ESKAPE relatives for confirmation.

23. Antibiotic Producing Bacteria from North Texas Soil

Shiloh Terrell, Alex Diaz, Lindsey Daniel, Claudia Gonzalez-Villarreal, Syeda Alam, Rajashree Pradhan, Khadiza Zaman, and Roxana Hughes
Department of Microbiology, University of North Texas, Denton, TX

Soil samples from the North Texas region were collected by 660 undergraduate students in the microbiology laboratory of the University of North Texas. Serial dilutions of the samples and selective media (Rhizobium, water agar, and 50% TSA) were used to isolate bacterial colonies from the samples. Colony morphology observations indicate a range of different colors, shapes, and margins among the bacteria. The incubation temperature of our isolates was 30^0 C. Bacterial colonies were re-isolated on 50% TSA media, and then grown in the presence of safe pathogens relatives to observe antagonistic bacteria, indicated by a “zone of clearing” – an area in which secondary metabolites might be produced. Single colonies were obtained using the four-quadrant streak method. Polymerase Chain Reaction (PCR) was performed on the isolates using primers designed on the 16S rRNA region. Gel electrophoresis confirmed 115 samples of amplified bacteria. The samples were sent for sequencing through MCLAB (Molecular Cloning Laboratories) DNA sequencing services. NCBI nucleotide BLAST sequence alignment was performed to identify the unknowns. The sequence results were used to construct a phylogenetic tree. The results suggest there are antibiotic producing bacteria in different locations across the North Texas region.

24. Discovery of Novel Antibiotics to Fight Antibiotic Resistant Bacteria

Haley Turner, Anna Holycross, and Mustafa Morsy
Department of Biological and Environmental Sciences, University of West Alabama, Livingston, AL

Antibiotic resistance is a serious problem worldwide due to the overuse of antibiotics. In the United States, 23,000 people die every year from infections caused by antibiotics-resistant bacteria or "super bugs". We participated in the Small World Initiative (SWI), which is an innovative program that encourages students to pursue careers in science while addressing a real-world health threat - the diminishing supply of effective antibiotics. We collected soil samples from East Mississippi and West Alabama, isolated diverse bacteria, tested these bacteria against clinically relevant microorganisms, and characterized those showing inhibitory activity. We isolated nearly 2,000 diverse bacterial colonies and tested them against the ESKAPE pathogens safe relatives (*Pseudomonas putida*, *Escherichia coli*, and *Staphylococcus epidermidis*) and *Salmonella Newport*. We identified 71 unknown bacteria as antibiotic producers that

produces inhibition zones on one or more of the tested pathogens. Antibiotic producers were characterized by the Biolog Omni log 96-well plates, which uses 94 different phenotypic tests including 71 carbon source utilization assays and 23 chemical sensitivity assays for bacterial identification. In addition, antibiotic producers were identified via PCR amplification and sequencing of 16S rDNA. Isolate #4 inhibited *S. Newport* (a food poisoning causing bacteria) was identified as *Serratia marcescens* using both 16S rDNA sequencing and the Biolog analysis. Chemical extractions were done for selected antibiotic producing bacteria and the extractions demonstrated that the antibiotic activity is retained when extracted and thus have compounds in solution. The chemical nature of the antibiotics produced are being determined using whole metabolome analyses and mass spectroscopy methods.

25. Searching Antibiotics in Spanish Land: SWI Experience at the Deutsche Schule Madrid

Cecilia Valenzuela, Irene Sánchez Méndez, Carlos Serna Bernaldo, Renée Martin, Frank Müller, and Bruno González-Zorn
Faculty of Veterinary, University Complutense of Madrid, Spain

The Small World Initiative, a crowdsourcing antibiotic discovery project, has arrived to Spain. Antibiotic resistance is a pressing global health issue, and it is essential to involve the public to fight against this threat. SWI's target population are students: pre-researchers, pre-politicians, pre-entrepreneurs and citizens of today and tomorrow. At the Deutsche Schule Madrid, 22 high school students were engaged in the project under supervision of pregraduate student members of the University Complutense Veterinary School. During the experiments, students take an active role in the fight against antibiotic resistance and experience what microbiology researching is. Looking for different places throughout Madrid, 11 soil samples were tested with a total of 158 bacterial isolates in 10% Triptone Soya Agar. The isolates were screened for antibiosis against ESKAPE-like pathogens: *Staphylococcus epidermidis*, *Enterococcus raffinosus*, *Escherichia coli*, *Enterobacter aerogenes*, *Acitenobacter baylyi*, *Pseudomas putida* and other bacteria like *Bacillus subtilis* and *Erwinia carotova*. Here, we show our results and present our candidates to antibiotic producers, including one with a potential broad-spectrum activity against Gram-positive and Gram-negative bacteria.

26. Isolating Microbes from Soil in Pursuit of Novel Antibiotics

Calvin Wilks and Wayne Hatch
Utah State University Eastern, Price, UT

Despite explicit forewarning on the severity of antimicrobial resistance, the number of infectious organisms that are adapting to current antibiotics continues to rise. However, efforts are being made to counter the influx of these antimicrobials, through the discovery of new antibiotics. Antibiotic producing bacteria are part of the vast population of microorganisms found in soils throughout the world. The goal of this research is to identify microbes from various soils that are potential antibiotic producers, isolate the organic extracts from these microbes, and test them for their antibiotic properties. Using procedures outlined by the Small World Initiative, several microbes were identified and characterized; and organic extracts were isolated and tested against known ESKAPE pathogens. Extracts from a characterized strain of *Proteobacteria burkholderia* inhibited *Bacillus subtilis*, and extracts from *Rhodococcus sp*., *Pseudomonas fluorescens*, *Pseudomonas sp*., and a *Bacilllus sp*. were found to inhibit the growth of *Staphylococcus aureus*.

27. Effect of Secondary Metabolites on Developing versus Developed Eukaryotic Models

Sabrina Yum-Chan, Emily McClure, Patricia Rossi, and Nichole Broderick
Department of Molecular and Cell Biology, University of Connecticut, Storrs, CT

Antibiotic-producing bacteria were isolated and characterized as part of the UConn SWI Microbe Hunters course. The purpose of this experiment was to observe the interactions between extracted secondary metabolites and the eukaryotic models of *Arabidopsis* and *Salvia*. Specifically, if there is a difference when the treatment is given to developing (seed) or developed (seedling) models. While the treatments affected the two plants differently, *Salvia* was of particular interest due to the noticeable discrepancies in growth patterns depending on its stage of development. The findings from this experiment show the complexity of how antibiotics and eukaryotes interact with one another.

TAPAS Presentations

1. **Engaged by Inhibition**
   Marne J. Bailey and Jeannette M. Pifer
   Lewis University, Romeoville, IL

   Project-based learning has been shown to lead to gains in both understanding and application of concepts in the classroom and laboratory. Here, based on comparisons of SWI implementation to that of another project, we zone in on striking visuals as the key to project ownership.

2. **Building a High School Research Program from the Ground Up**
   Brian Gerard Blair
   Garrison Forest School, Owings Mills, MD

   In December we had no room, no equipment or supplies. By the end of January, we had launched our Small World Initiative research class. This is our story: One school's quest to inspire the female scientists of tomorrow, and why high school is the place to start.

3. **Training up the SWI**
   Debra Davis
   Wingate University, Wingate, NC

   The Small World Initiative cohorts have increased in size dramatically each year since the first group was trained in 2013. The training process for new participants (SWIPIs) has since evolved to accommodate this significant increase. The week long hands-on workshop still occurs each summer, and has become a breeding ground of new relationships, collaborations, and innovation.

4. **Scaling the Small World Initiative**
   Roxana Hughes
   University of North Texas, Denton, TX

   The Small World Initiative was implemented at the University of North Texas, where 600 students a year take Microbiology. To scale the project to this number of students, we made adaptations such as having students work in pairs for soil collection and dilutions and the use of a limited set of culture media options. These and other modifications will be discussed.

5. A Novel Assay to Screen Soil Samples for Bacterial Type III Secretion Systems Inhibitors

Julie Torruellas Garcia
Nova Southeastern University, Fort Lauderdale, FL

Commonly used antibiotics are becoming less effective; therefore, the development of new antimicrobials that bacteria will not become resistant to is a necessity. One innovative strategy is to find antimicrobials that target virulence factors in bacteria. This strategy will reduce the selective pressure on the bacteria to mutate since virulence factors are often times not needed for growth. Some pathogenic bacteria including *E. coli*, *Salmonella*, *Shigella*, *Chlamydia* and *Yersinia* species utilize a type III secretion system (T3SS), which are needle-like structures on their surface used to inject host cells with toxins in order to evade our immune system and cause infection. Blocking the T3SS inhibits their ability to cause infection. Therefore, the T3SS is an ideal target for novel antimicrobials. For this Tapas Talk, I will share a novel assay that can be used to screen soil samples for *Y. pestis* T3SS inhibitors.

6. Phylogenetic Tree Drawing: A SWI Lab Activity Comparing Bacterial Morphology to DNA Sequence

Todd L. Kelson
Biology Department, Brigham Young University Idaho, Rexburg, ID

We have developed a 2-week lab activity evaluating morphological vs. molecular phylogenies, as follows: During week 1, students perform internet research of 9 different species (6 of which are the ESKAPE pathogens) and are asked to draw a tree based on physical characteristics of these species (shape, motility, spore-forming, use of oxygen, gram stain, and diseases caused by pathogenic bacteria). During week 2, they perform BLAST analysis to identify the genus of their bacterial isolate, additionally, they analyze the 16S rRNA gene sequence of the same 9 species from the prior week and compare the results of the 2 trees.

7. **Keeping Students on Schedule in the Antibiotic-Discovery Process of SWI**
Diane Baronas-Lowell
Department of Biological Sciences, Charles E. Schmidt College of Science, Florida Atlantic University, Boca Raton, FL

The Small World Initiative was re-implemented at Florida Atlantic University in four non-STEM majors' labs (with 92 students) in Fall 2016 and expanded to eight labs (with 182 students) in Spring 2017. Some of the methods that were used to keep students on task during these (once-a-week-110-minute) labs while simultaneously keeping the momentum of pursuing antibiotic-producing bacteria in South Florida will be discussed, including student swapping of antibiotic producers.

8. **Inspiring Students in Public Outreach and Community Engagement Events**
Alice Lee
North Carolina State University, Raleigh, NC

NC State is committed to public outreach and community engagement through its diversity of campus programs that reach local, national, and international partners. As part of this commitment, our SWI students were inspired to take on the SWI-CDC "Do Something About Antibiotics Challenge." This talk will be about how to inspire and support your students in meaningful service learning and community engagement activities.

9. **Let's Talk Citizens' Science**
Mary G. Miller
Baton Rouge Community College, Baton Rouge, LA

Citizens' science projects engage students, who would not usually be interested in science, to be part of large scale data collection and expose them to research techniques. This symposium will be used to describe the process of transforming SWI into a citizens' science project that can be held on campus or a community event.

10. The Benefits of Field Research as Part of SWI

Mary G. Miller
Baton Rouge Community College, Baton Rouge, LA

Small World Initiative provides ownership and a sense of research adventure to all who are involved. For the last two semesters, I have had added field research component to my SWI class which has not only increased the excitement of the students in the lab, but has also increased the cohesive nature between the students. This tapas talk will outline how to implement small to large field research components and the benefits.

11. Collaborating with Chemists: Interdisciplinary CUREs at a Community College

Heather Seitz
Johnson County Community College, Overland Park, KS

Johnson County Community College, faculty from the microbiology department as well as the chemistry department have been partnering to work on the SWI. Following the semester's work in microbiology, the bacterial isolates found and screened by students are handed off to Principles of Organic and Biological Chemistry. Students in the chemistry course then work on extracting and separating the mixtures using thin layer chromatography and column chromatography. The samples created by chemistry students are then given back to the microbiology students to perform bioautography to see if the components of the samples inhibit ESKAPE pathogens. This approach has been a wonderful way to connect students, keep students engaged in research beyond their initial semester, as well as enriching the work we do as faculty. In this presentation, I will highlight how our program is enhanced with this interdisciplinary work and share what we have learned.

12. Misconceptions and Corrections of a First Timer

Misty Dawn Thomas
Department of Biology, North Carolina A&T State University, Greensboro, NC

The SWI protocols were implemented for two semesters at North Carolina A&T State University into a General Microbiology curriculum of 75-100 students per semester, comprised of twelve different majors. Here I will discuss the success, the common misconceptions, and the corrections that we made in our first year in the program.

13. Expanding SWI Towards Transposon Mutagenesis and Bioinformatics

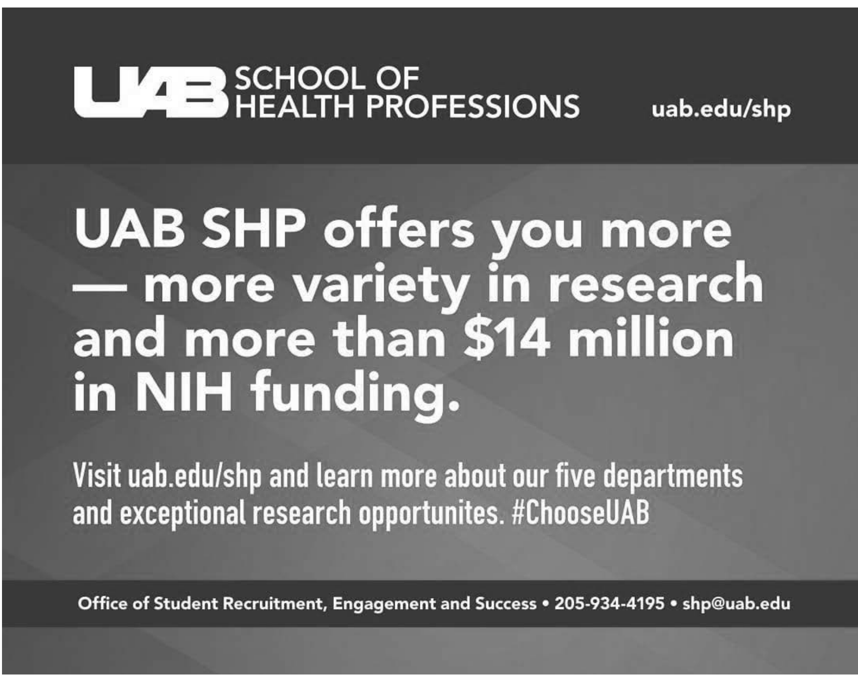
Hans Wildschutte
Bowling Green State University, Bowling Green, OH

We offer an alternative approach to chemical extraction and antibiotic discovery. By utilizing transposon mutagenesis, we identify loss of inhibition phenotypes, and subsequent whole genome sequencing and linker-mediated PCR are used to identify the mutated genes. With these data in hand, bioinformatic approaches are used to characterize the strains and gene clusters.

Gold Sponsors

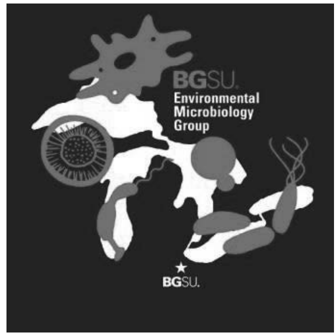
The University of Alabama at Birmingham School of Health Professions

The UAB School of Health Professions (SHP) is the fastest growing School at UAB and one of the largest health professions schools in the nation. Within our five departments, we have more than 20 programs and nearly 40 degrees and certificates at the baccalaureate, masters, and doctoral degree levels – one is right for you.



Bowling Green State University

The Ph.D. program in Biological Sciences at Bowling Green State University (BGSU) provides student training from a diverse group of faculty involved in numerous areas of molecular and microbiology research. Microbiology research includes antibiotic discovery and inhibition against human and plant pathogens, harmful algal blooms in worldwide lakes, metagenomics of microbial communities, virus evolution and host-virus interactions, bacterial engineering for biotechnology, and ice nucleation by microbes. Cutting-edge molecular research addresses genomic diversity of organisms in a range of diverse human and non-human systems using unique collections of sequenced genomes. Our goal is to prepare students for academic and professional careers by providing high-quality graduate and leadership training while working within national and international scientific communities. Consistent with our mission, BGSU students are provided a rigorous and comprehensive graduate training curriculum to promote training and exposure in molecular and microbiology research and teaching areas. Please visit the Department of Biological Sciences web page for more information https://www.bgsu.edu/arts-and-sciences/biological-sciences.html.



Located at the western end of Lake Erie in Ohio near the Great Lakes, BGSU educates more 17,000 students annually. Recognized as one of the “best cities to live in Ohio”, Bowling Green is a college town with a friendly atmosphere and a low-cost of living. Interested candidates should contact Dr. Julia Halo Wildschutte at juliahw@bgsu.edu.

BGSU Program Highlights include:

- A unique opportunity to study in a department that has an environmental microbiology group

- The molecular and microbiology group focuses on important concerns including harmful algal blooms, antibiotic discovery, biotechnology, and host-viral interactions
- Faculty are nationally and internationally recognized researchers and scholars
- Coursework includes a foundation in molecular and microbiology including recent technological advances and research techniques
- Students are supported through research and teaching assistantships during their graduate career
- Most research groups incorporate various training aspects including field sampling, wet-bench experimentation, genome sequencing and analysis, and bioinformatic research

Silver Sponsors

- Alabama College of Osteopathic Medicine
- Mississippi State University - Center for Distance Education
- The University of Southern Mississippi
- William Carey University College of Osteopathic Medicine

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KEYNOTE

A CONVERSATION WITH

Dr. Jo Handelsman

Director
Wisconsin Institute for Discovery

Professor
University of Wisconsin-Madison

Founder
Small World Initiative

Thursday, June 1st, 2017

www.smallworldinitiative.org