Conference for Undergraduate Educators

Xavier University of Louisiana
New Orleans, Louisiana
May 21 – 23, 2004

Poster Session & Abstracts
2004 ASMCUE Poster Presentations

Saturday, May 22, 2004
7:00 – 9:15pm
University Center, 3rd Floor, Ballroom B

All posters will be available for viewing from 7:00 – 9:15pm. Authors will present their posters in one of three sessions: A, B or C. The presentation times are:

#-A – 7:00-7:45pm
#-B – 7:45-8:30pm
#-C – 8:30-9:15pm

Teaching Approaches

1-A
Reading AND Writing? How to Promote Both in a General Microbiology Course
*Merrilee G. Anderson. Mount Aloysius College, Cresson, PA.

2-B
Connecting The Dots: Integrating Practice In An Allied Health Microbiology Course
Gail S. Begley. Northeastern University, Boston, MA.

3-C
An Idiot's Guide to Teaching Microbial Physiology and Ecology in a General Microbiology Class
R. Benoit. Virginia Tech, Blacksburg, VA.

4-A
Magnifying Self-Assessment of Teaching and Learning By Focusing On Course Objectives
Donald P. Breakwell. Brigham Young University, Provo, UT.

5-B
Improving Student Learning in Immunology, Through Effective Student Feedback Self-Studies
Maureen M. Dawson. Manchester Metropolitan University, Oxford, UK.

6-C
Think Aloud Method to Investigate Problem Solving Strategies of High Achievers and Low Achievers Among Students Taking a General Microbiology Course
*J.I. Ebomoyi, R.R. Jurin, and M.E. Heimbrook. University of Northern Colorado, Greeley CO.

7-A
Genomics Research as an Organizing Thread to the Microbial/Molecular Curriculum
Brad Goodner and Cathy Wheeler. Hiram College, Hiram, OH.

8-B
Human - Microbe Interactions: A Course for Non - Biology Majors
Robert I. Krasner. Providence College, Providence, RI.

9-C
Teaching Epidemiology with System Modeling
Steve Lindeman and Clark Gedney. Purdue University, West Lafayette, IN.

10-A
Different Teaching Styles Had No Effect on Students' Preference of Learning Activities
Mary F. Lux. University of Southern Mississippi, Hattiesburg, MS.
11-B  
Skill Stations Develop Student Skills in the Science Classroom  
**Stephen C. Nold** and Michele D. Z wolinski. University of Wisconsin–Stout, Menomonie WI.

12-C  
A Non-Major Microbiology Course With Emphasis on the Scientific Research Process  
*Iruka N. Okeke*. Haverford College, Haverford, PA.

13-A  
Incorporating Bioinformatics into the Life Science Curriculum: A Comprehensive, Multidisciplinary Approach  

14-B  
Developing Writing Skills in Science Undergraduate Education by Utilizing a Multi-level Library Research Project  
**Karen M. Smith**. University of British Columbia, Vancouver, BC, CANADA.

15-C  
Building Small-Group Social Skills in College Classrooms  
**Michele D. Z wolinski** and Stephen C. Nold. University of Wisconsin–Stout, Menomonie, WI.

---

**Hands-on Projects**

16-A  
The Training of Undergraduate Science Majors in Virological Techniques: Research Application to Anti-viral Activity by Comestible Juices.  
P. Cohen, S.-A. Phillip, and *S.M. Lipson*. St. Francis College, Brooklyn Heights, NY.

17-B  
From Soil to Sequence: A Convincing Demonstration of the Predominance of Uncultured Bacteria in a Soil Sample  
Christopher J. Distel and **Gerald L. Kreider**. Albright College, Reading, PA.

18-C  
Identification and Characterization of *Staphylococcus aureus* and Virulence Properties in the Teaching Lab Using Commercial Test Kits  
Beverly A. Dixon¹, Lynn Benjamin* and **Kevin Mangan**². ¹California State University, Hayward, CA and ²Denka Seiken Co., Ltd., Tokyo, Japan.

19-A  
Integrating Scientific Inquiry, Molecular Biology, and Service-Learning into an Undergraduate Environmental Microbiology Laboratory  
**Milutin Erbeznik**. Albion College, Albion, MI.

20-B  
Gene Hunters: A Semester-long Project for a Course in Biotechnology  
*Mary B. Farone* and Anthony L. Farone. Middle Tennessee State University, Murfreesboro, TN.

21-C  
Comprehensive Immunological Laboratory Exercises  
**Ehleen M. Hinze**. University of British Columbia, Vancouver, BC, Canada.
22-A
Microbial Diversity in Great Smoky Mountains National Park: A Tool for Teaching Microbiology through Traditional and Modern Approaches
Seán P. O'Connell. Western Carolina University, Cullowhee, NC.

23-B
Creation of Laboratory Exercises for a Non-majors Course in Bioterrorism
John R. Phythyon, Candice Leach, and Naomie Kraus. St. Norbert College, DePere, WI.

24-C
Bioluminescence Workshop - To Study the Detection and Regulation of Bacterial Lux Gene Expression

25-A
A New Twist on Bacterial Unknowns: St. Patho General Hospital
Patty Shields. University of Maryland, College Park, MD.

26-B
Critical Connections: Facilitated Learning Through Interdisciplinary Undergraduate Research Involving Retrospective Epidemiological Studies and Memories of Older Adults of Influenza (1918) and Polio (1940-1960)

27-C
Creation of a Bioinformatics-driven Microbial Molecular Genetics Laboratory
Michael L. Summers. California State University Northridge, Northridge, CA.

28-A
Learning about Microbial Diversity through a "Microbe Collection"
Debra L. Wohl. University of Richmond, Richmond, VA.

29-B
Teaching the Identification of Microbes: Traditional and/or Molecular
Penelope Worthington and Paul Blum. University of Nebraska-Lincoln, Lincoln, NE.

Independent Projects

30-C
DYOE (Design Your Own Experiment): A Model for One-Week Independent Laboratory Projects in a Microbiology Course
Jason C. Baker. Missouri Western State College, St. Joseph, MO.

31-A
When Engineers and Microbiologists Work Together
Larry Baresi. California State University Northridge, Northridge, CA.

32-B
Environmental Microbiology: A Multidisciplinary, Multi-class Approach

33-C
Incorporating an Inquiry-based Culminating Project into a Bacterial Diversity Course
B. Bratina and M. Winfrey. University of Wisconsin-La Crosse, La Cross, WI.
34-A
Biodegradation of Plastic Bags: A Cross-Disciplinary Project for Students in Microbial Ecology, Chemistry, Material Science and Environmental Studies

35-B
Original Research Conducted within Instructional Biology and Chemistry Laboratories at Eastern Michigan University
Daniel Clemans¹, David Kass¹, Elizabeth Butch², and Steven Pernecky². Departments of Biology and Chemistry, Eastern Michigan University, Ypsilanti, MI.

36-C
Fecal Contamination Source Tracking Using Discriminant Function Analysis of Antibiotic Resistance Patterns
M.A. Mills and M.A. Furlong. Clayton College and State University, Morrow, GA.

37-A
Integration of Student Independent Investigations into the Syllabus of an Applied and Environmental Microbiology Course as a Means to Encourage Interest in Microbiology Research
Richard T. St. John. Widener University, Chester, PA.

38-B
Exploring the Diversity in Aerobic Bacterial Communities of Polluted Yamuna Waters and Comparing it with an Adjacent Institutional Area - An Undergraduate Project
*S. Krishna Sundari. Jaypee Institute of Information Technology (JIIT) Noida, U.P., INDIA.

39-C
The Resistance Movement - Antibiotic Resistance of Inland Waters in Southeastern Michigan
Bridgette West. Eastern Michigan University, Ypsilanti, MI.

40-A
Developing a Research Program for Widespread Undergraduate Participation: Phylogenetic Typing of Cultivated and Uncultivated Microflora of Soil Communities
Krystle A. Ziebell, Grace S. Lee, Erika Wolff, Cindy Tamae, Lavitania Bismart, and Jeffrey H. Miller. University of California, Los Angeles, Los Angeles, CA.

---

Outreach

41-B
Can Local Health Care Agencies Safely Handle Biological Terrorism Microorganisms?
Jameel Al-Dujaili, Marlene Foreman, and Melanie Foreman. Louisiana State University at Eunice, Eunice, LA.

42-C
Microbiology for Teachers: The Trickle Up Effect. A Course for High School Educators
Veronica Little and Benjie Blair. Jacksonville State University, Jacksonville, AL.

43-A
Learning Through Teaching in a Non-Majors Microbiology Class
Heidi Elmendorf. Georgetown University, Washington, DC.
44-B
Microbial Problems in Biocomplexity: Opportunities for Research and Educational Collaboration of Scientists, Secondary School Educators, and Students
Regina Herrick¹, Luci Levesque², Marjorie Tennyson³, Donald Berthiaume⁴, Gail Fletcher⁵, Christine Tellarini⁶, David Almeida⁶, Karen D. Moulton⁶, Jennifer Jamison⁶, Amanda Andersen⁶, Sonya Hawkins⁶, Kimberly Brothers⁶, Elizabeth Richards⁶, Allison Hopkins⁶, Barry Larman⁶, Beth Hill⁶, and S. Monro Duboise⁶. ¹Skowhegan Area High School, Skowhegan, ME, ²Capital Area Technical Center, Augusta, ME, ³Hall-Dale High School, Farmingdale, ME, ⁴Portland Arts and Technology High School, Portland, ME, ⁵Western New England College, Springfield, MA, and ⁶University of Southern Maine, Portland, ME.

45-C
A New Generation of Scientific Teachers: Training Graduate Students to Teach
Sarah Lauffer and Jo Handelsman. University of Wisconsin-Madison, Madison, WI.

46-A
Integrating Traditional Ways of Knowing with Clinical Microbiology
Tina Melin and Kathleen Douglass. Ketchikan General Hospital Laboratory, Ketchikan, AK and Manilaq Health Center, Kotzebue, AK.

47-B
The Unexpected Protocol: Combine Urban Youth, Community Outreach and High Throughput Cloning to Achieve Results

48-C
Service Learning in Allied Health Microbiology
Marie Panec. Moorpark College, Moorpark, CA.

49-A
Bridges to the Future- Increasing Minority Student Participation in the Biomedical Sciences

50-B
A Successful Distance Learning Microbiology Course for High School Students
L. Rodriguez¹, C.A., Moreno¹ and V. Tucker²
¹The University of Texas Health Science Center at Houston and the ²Spring Branch Independent School District, Houston, TX.

51-C
Upper-level Undergraduates Teach Marine Microbiology to 5th Grade Students
*Elise R. Sullivan. University of New Hampshire, Durham, Durham, NH.

52-A
Influence of >100 Years of Tannery Activity on a Wetland Community: A Service-learning Project for Undergraduate Microbiologists
*David S. Treves. Indiana University Southeast, New Albany, IN.

Teaching Tools

53-B
A Virtual Laboratory for Microbiology on CD
G.J. Delisle and L.L. Tomalty. Queens University, Kingston, Ontario Canada.
54-C
Teaching Bacterial Pathogenesis Using Bioinformatics and Genomics Approaches
*Janelle Hare. Morehead State University, Morehead, KY.

55-A
Applying the Web-based IMMEX Platform to Teaching the Lactose Operon
David F. Johnson¹, Joycelin Palacio-Cayetano² and Ron Stevens². ¹University of California, Irvine, CA and ²The IMMEX Project, UCLA School of Medicine.

56-B
Using On-line Games to Teach Microbiology
Leslie M. Miller and Vicky Estrera. Rice University, Houston, TX.

57-C
Choice of Treatment for HIV Infected-Individuals: An Exercise for Microbiology Courses
Maria D. Suarez. Holy Family University, Philadelphia, PA.

58-A
Learning Support Materials to Accompany the Video Series 'Unseen Life on Earth':
Produced by Students for Students
Joanna Verran. Manchester Metropolitan University, Manchester, UK.
1-A
Reading AND Writing? How to Promote Both in a General Microbiology Course

*Merrilee G. Anderson*. Mount Aloysius College, Cresson, PA.

At Mount Aloysius College, the general microbiology course is required for multiple allied health majors. Approximately 120 students enroll in the course each academic year. To facilitate student learning beyond the traditional blackboard lectures, a “topical summary” writing project is assigned. The assignment consists of ten one-page reports due at regular intervals in the fifteen-week semester. First the student must find a source associated with the current lecture topic. Sources include websites, television programs, health brochures, and newspaper or scientific journal articles. In each one-page report, the student begins by summarizing the specific content of the source, with attention to details such as scientific nomenclature. The student concludes the report with a personal interpretation of the source as it relates to the lecture topic. In this portion of the report, the student must describe the relevance of the source, as well as any opinion about the research involved or contribution of the work to society, either beneficial or detrimental. Students are encouraged to explore topics that they do not fully understand or that they have an interest in beyond the scope of the course. Points for the assignments are awarded for content, grammar, and adherence to due dates. For the final topical summary, students are asked to self-assess their experience. The assignment is worth 6% of the final grade. Topical summary examples and student self-assessments will be presented.

2-B
Connecting The Dots: Integrating Practice In An Allied Health Microbiology Course

Gail S. Begley. Northeastern University, Boston, MA.

A program of course integration was undertaken in response to concerns that separate lectures and teaching assistant (TA)-led laboratories don’t allow students to adequately connect course concepts. The program included modifying the lectures to more closely coincide with laboratory exercises, emphasizing in lectures how particular lab techniques and exercises demonstrate course concepts, and working with TAs to implement an integrated group project involving lab work, in-class activities, a group presentation, and an individual report. Assessment included testing, student evaluations, student comments on project reports, and TA appraisals. Overall, students responded very well to the integration, however there were several surprising results. In anonymous evaluations in which students were asked to grade 11 course components and indicate what type(s) of learning each facilitated, students gave lectures and on-line course materials the highest grades overall. But the top ranking components in terms of making connections were lectures (80% of students) and laboratory experiments/exercises (80%), followed by lecture notes on-line (51%) and in-class group project activities (51%). The latter result is remarkable because students rated the in-class project activities at the bottom of course components in their subjective grading, but near the top in making connections. The most common comment on project reports (non-anonymous) was that the knowledge/skills acquired in the project would be most useful in students’ personal lives (29% of comments). They also indicated that the project helped to integrate lecture and lab topics, i.e., the original intent (18%), and that the information would be useful in their professional lives (18%).
3-C
An Idiot's Guide to Teaching Microbial Physiology and Ecology in a General Microbiology Class

R. Benoit. Virginia Tech, Blacksburg, VA.

Microbial physiology is one of the difficult problem areas facing an instructor of a General Microbiology class. Success is possible if the student can recall his/her general chemistry, and the instructor can present the material in an understandable context. The student often drowns from pathway overload and intermediate chaos. Therefore, I devised an Idiot's Guide to Teaching Microbial Physiology in General Microbiology as a forest eye view introduction to physiology and ecology areas (trees/pathways on parade). The present draft contains 17+ subject bullets. Many of the bullets are designed to link microbial physiology and microbial ecology. The bullets listed below are guide samples:

Bullet 1. A microbe that doesn't understand thermodynamics is a dead microbe. No energy, no life. Some microbial species can survive short term budget deficits in Nature if they have a long term strategy.

Bullet 2. Hydrogen is the fuel of life. Carbon metabolism is important but understanding ATP generation potential requires an eye for following electrons between reactions. The Niagara Falls/redox potential analogy.

Bullet 3. Microbes invented the Biochemical Unity of Life game that governs all biological species. However, microbes also invented an exception(s) to nearly every rule in the game. Given habitat diversity of planet Earth, expect surprises as microbes play out the survival phases of their life-cycle. Cannibalism is acceptable.

Bullet 4. Never bet against a mean junk yard dog (indigenous microbial species) who fights a mean visiting junk yard dog (another microbial species) inside its territory (niche defense). The challenger sometimes enjoys short term advantage.

Copies of the complete guide will be available at the paper presentation.

4-A
Magnifying Self-Assessment of Teaching and Learning By Focusing On Course Objectives

Donald P. Breakwell. Brigham Young University, Provo, UT.

Most instructors assess their teaching but often the process of self-assessment is not a formal one. This study describes one approach using teaching and learning objectives to identify areas for course improvement in an allied health microbiology class. Three kinds of teaching and learning objectives were documented in a student study guide: preparation, in-class, and skill objectives. Preparation objectives were designed to focus students on specific material to be studied before coming to class. In-class objectives defined what the instructor wanted to accomplish in class. Skill objectives articulated what the students should have acquired by their participation during each class period. These objectives were used to develop assessments for the class. Student preparation was assessed using a reading quiz. Students used an A, B, C, D and E grade scale to report how they felt the in-class objectives were met. Skill objectives were assessed using concept quizzes. Whereas reading quiz questions were focused on the lower order skills of knowledge and comprehension, concept quiz questions were focused on higher order ability to analyze, synthesize, and evaluate. Similar to other studies, there was not a strong correlation (r = 0.44) between how students perceived their preparation and how they performed on the reading quizzes. Distributions of grades for in-class objectives assessment were useful for identifying problem areas perceived by the students. Analysis of concept quiz score means and standard deviations indicated potential areas for improved teaching and learning. Assessment of objectives can provide a meaningful way of focusing in on specific parts of a course that need improvement by either changing the way learning occurs or by redefining an objective.
**5-B**

**Improving Student Learning in Immunology, Through Effective Student Feedback Self-Studies**

*Maureen M. Dawson.* Manchester Metropolitan University, Oxford, UK.

In the UK, feedback is routinely obtained from students at the end of a course, usually through the use of a standard, University-wide questionnaire. Analysis is used for evaluation and monitoring of a course, and may inform future changes to the course though it cannot help the current group of students. The work presented here involved the collection of feedback from students taking a third year course in Immunology. The aim was to improve learning for the current group of students since feedback taken during the course would enable changes to be made to assist their learning. The third year course in Immunology is delivered twice a year. The course takes students from several programmes, with a range of academic backgrounds. Feedback was required to determine which aspects of the learning and teaching activities were effective for students on different programmes, and whether any groups felt that their academic backgrounds were inadequate for the course. Halfway through the course, students, in groups of 2-4, were emailed a questionnaire of the 'Continue, Start, Stop' variety with additional questions about their academic backgrounds. Feedback obtained was quantitatively and qualitatively superior to that obtained from using the 'standard' questionnaire and enabled immediate changes to be made, for the benefit of the current cohort of students. This poster will give a full report of the methods used and the results obtained from comparing feedback obtained from students taking the course in Semester 1 (obtained by University questionnaire) and Semester 2, the group involved in the feedback study.

---

**6-C**

**Think Aloud Method to Investigate Problem Solving Strategies of High Achievers and Low Achievers Among Students Taking a General Microbiology Course**

*J.I. Ebomoyi, R.R. Jurin, and M.E. Heimbrook.* University of Northern Colorado, Greeley CO.

Understanding biological concepts demands problem solving, therefore it is imperative to understand how people learn and problem-solve. The decision-making process was studied for high and low achievers using a unique computer program involving problem solving. Students (n=18) in a microbiology class participated in a think aloud protocol (verbalization of thoughts) while solving microbiology problems in the Interactive multimedia exercise (IMMEX) windows software. All participants attempted "Microquest" (focuses on cellular processes and mode of action of antibiotics), and "Creeping Crud" (focuses on the cause, origin and transmission of diseases). Participants also responded to the "Motivated Learning Strategy questionnaire" (MLSQ). Within case analysis, summaries and phenomenological approach were methods of analysis utilized. Of the 18 participants, 8 (44%) were allied health students and 10 (56%) were biology major students. There were 10 (56%) who solved microquest and 16 (89%) who solved creeping crud. Using final scores, 8 were categorized as low achievers with 5 as high achievers for microquest, and 5 (31%) categorized low and 6 (35.5%) high for creeping crud. For microquest, six allied health students and one Biology major were classified as low. In general, high achievers used fewer steps, spent less time and had a more focused approach than low achievers. Common attributes and strategies found among most problem-solvers included metacognitive skills, writing to keep track, using prior knowledge, and elements of frustration. This study is useful for consideration while developing curriculum and criteria for evaluation especially in classes with students from different disciplines.
7-A  
**Genomics Research as an Organizing Thread to the Microbial/Molecular Curriculum**

*Brad Goodner* and *Cathy Wheeler*. Hiram College, Hiram, OH.

Genomics has certainly transformed biological research, but it also can revolutionize undergraduate biology education. Over the past 3 years at Hiram College, we have woven original bacterial genomics research throughout the lab (and class) components of genetics, molecular & cellular biology, microbiology, and bioinformatics courses. In this poster, we present six multi-week research vignettes: generation of genetic/physical maps of bacterial chromosomes, construction of subgenomic libraries, functional genomics, gene expression profiling, bioinformatics, and comparative genomics. Each vignette will cover the research question, how the project covers typical skill development and lab topics, how the course-based research adjusts to fit the progress of the overall project, novel learning opportunities, and how the course-based research ties into independent projects, collaborations, and outreach to high schools. The collaboration and outreach angles are prime areas for funding by government agencies and NGOs. Recent course-generated data will be presented on the chromosome map of *Chromohalobacter salexigens*, functional genomics and gene expression profiling of multiple genes from the previously sequenced *Agrobacterium tumefaciens* C58 genome, subgenomic library construction and comparative genomics of multiple *Agrobacterium* strains, and bioinformatics- and map-based gap closure of the *Sphingomonas elodea* genome. This work is currently supported by grants from NSF and USDA.

8-B  
**Human - Microbe Interactions: A Course for Non-Biology Majors**

*Robert I. Krasner*. Providence College, Providence, RI.

Today’s news abounds with accounts of microbial diseases. SARS, influenza, Aids, and norviruses are but a few examples. Immunization and its possible link to autism and antibiotic resistance are topics of current concern. Trade books, magazines, and movies dealing with microbes and their consequences are best sellers. All this despite the optimism of the 1960’s that infectious diseases would soon be conquered. Nevertheless, few courses for non-biology majors are offered. Microbiologists are challenged to develop a “Microbes and Man” type course for non-science undergraduates in order that they better understand the microbial world and its impact on their lives.

For the past five years, a one-semester 3 credit course focused on human-microbe interactions, has been offered at Providence College (Providence, RI). The course is a hybrid of public health and microbiology and is designed to increase awareness of new, emerging, and reemerging infectious diseases and their societal consequences. The recently published (ASM Press) text by Robert I. Krasner, “The Microbial Challenge,” targeted for non-biology majors, is used. Topics include the biology and diversity of microbes, beneficial aspects, concepts of microbial disease, control measures, plagues, and biological weapons. The course lends itself to critical thinking as, for example, position papers on mandatory anthrax immunization in the military, the Gallo-Montagnier AIDS controversy, and the immunization-autism link. Based on its relevancy to today’s human affairs, the course has been very popular.
9-C
Teaching Epidemiology with System Modeling

Steve Lindeman and Clark Gedney. Purdue University, West Lafayette, IN.

Systems thinking is an often underemphasized aspect of biological training at the undergraduate level with tremendous educational value. By concentrating on quantitative models of flow through a defined system, students are challenged to comprehend the workings of a process beyond a basic qualitative understanding. In order to train undergraduate students in the basics of system thinking while concurrently teaching rudimentary epidemiology, we have developed deterministic models in STELLA and LabVIEW of a bioterrorist smallpox attack corresponding to recently published theoretical data. These models allow for conceptualization and visualization of smallpox disease progression, elucidate the important factors involved in smallpox transmission (and potential points of transmission control), and allow for “what if” analyses to underscore the potential threat as compared with other infectious agents, such as anthrax, and delayed catastrophic events such as the HIV pandemic. These models also serve as an experimental engine for an inquiry-based learning shell, as the student is able to modify the myriad variables involved in smallpox transmission and disease progression. The student, utilizing feedback in the cost (both in lives and in dollars) of an attack, is asked to manipulate the system and to predict the results of his or her experimentation. Furthermore, these models allow for evaluation of the impacts of differential vaccination and quarantine strategies, bringing the student to a broader realization of the role of scientific inquiry in public policymaking and introduction to public health management as a career option for students possessing an undergraduate biology education.

10-A
Different Teaching Styles Had No Effect on Students’ Preference of Learning Activities

Mary F. Lux. University of Southern Mississippi, Hattiesburg, MS.

A survey was conducted among students in four sections of a community college microbiology course. The course was offered in the summer semesters of 2002 and 2003 at the Pearl River Community College Forrest County Center. An afternoon section and an evening section were taught for both summers. Each section met once a week for a five-hour session that included both a lecture and a laboratory component. The lecture component of the 2002 evening section and the 2003 afternoon night section were taught in a traditional lecture format. The lecture component of the 2002 afternoon section and the 2003 evening section were taught with the inclusion of active learning strategies. The active learning strategies included creating illustrations, completing tables, working with small groups, and answering instructor-designed questions. The students were given an exit survey at the end of each course. The survey included twenty questions that addressed the students’ perceptions of the effects of various activities on their learning of course materials. A total of 51 students participated in the study. The control groups included 24 students and the test groups included 27 students. The mean, standard deviation, and independent T-test values for each of the 20 items will be presented. There were no statistical differences in the responses between the traditionally-taught sections and the active learning sections. Students reported that activities that did not enhance learning were taping lectures or lecture notes and studying with background noise. Student activities that enhanced learning were mnemonic devices, lab experiments, class questions (with student responses) and classroom interaction with other students. Students responded that they learned best by listening in class, taking notes, and rereading notes.
11-B
Skill Stations Develop Student Skills in the Science Classroom

Stephen C. Nold and Michele D. Zwolinski.
University of Wisconsin–Stout, Menomonie WI.

Science education is predominately content-based, requiring students to demonstrate knowledge of their field. But before students can enjoy academic success, they must learn the skills of knowledge acquisition. Scientific knowledge is constantly expanding, and acquisition skills become more important after students leave college and enter the workforce or become enlightened citizens. To directly address student skill deficits, we developed and tested a series of short exercises. These “skill stations” are flexible, instructor-tailored modules that can be used during lecture or laboratory sessions. A companion study “Building Small-Group Social Skills in College Classrooms, M.D. Zwolinski and S.C. Nold” measured the effects of skill stations on student performance. This presentation shares how to include skill stations in any course. We share an example semester, including core small-group social skills and selected critical thinking, study, time management, and information management skills students need for scientific knowledge acquisition. We also present our on-line skill station resource, an interactive, curated collection that will grow as users submit their own contributions. This approach supports the growing trend in science education toward skill development and knowledge acquisition. Further information about this innovative approach is available via the following web site: www.uwstout.edu/biology/nold.

12-C
A Non-Major Microbiology Course With Emphasis on the Scientific Research Process

*Iruka N. Okeke. Haverford College, Haverford, PA.

Science literacy, an integral part of broad based undergraduate education, can be effected through rigorous but engaging courses for non-science majors. One such course was designed to introduce non-majors to basic concepts in microbiology, immunology and epidemiology before focusing in on selected tropical pathogens. Required readings were assigned from a non-majors’ microbiology text and a popular public health book, and students were introduced to the primary literature. A written commentary, on a peer-reviewed scientific paper, was part of mid-course assessment. At the end of the course students were asked to submit a ‘Grand challenges in Global Health’ proposal according to guidelines posted at www.grandchallengesgh.org. (This original request for proposals was widely advertised in the scientific community early this year. The call aimed to generate a list of focal research areas that could produce a significant impact on health in developing countries). When the results of the official and class call were compared, 18 of 23 class papers that fit the true definition of a ‘Grand Challenge’ corresponded to published ideas that had been generated from the scientific community and 10 of the 14 official ‘Grand challenges’ were proposed by the class at least once. The results of the class call suggest that the course was successful in conveying the scientific research process and that non-majors can develop feasible research ideas. In addition, the coincidence between results of both calls suggest a limited number of challenges, albeit formidable ones, must be overcome to produce a significant impact on global health.
13-A
Incorporating Bioinformatics into the Life Science Curriculum: A Comprehensive, Multidisciplinary Approach


Recent advances in analyzing DNA and protein sequences are revolutionizing the biological sciences. Students must have the opportunity to learn bioinformatics skills to function in the scientific community. Massive amounts of data, complex algorithms scattered among various web locations and lack of broad faculty expertise can pose significant barriers in attempts to comprehensively integrate bioinformatics into undergraduate curricula. To address this problem, nine faculty members from three departments have collaborated on a project to incorporate bioinformatics across the life science curriculum. The goals of the project were to use bioinformatics to illustrate theoretical concepts in lectures, to allow students to analyze data in the laboratory and to increase enrollment in an undergraduate Bioinformatics "capstone" course. Faculty participated in workshops to learn how to use Biology Workbench, a free, web-based collection of bioinformatics tools maintained by the San Diego Supercomputer Center. Exercises were developed, peer-reviewed, revised and implemented in 12 undergraduate life science courses. The timing and format of the capstone Bioinformatics course was adjusted to accommodate increased enrollments and facilitate student learning. Students have benefited by acquiring marketable skills, enhancing their understanding of basic biological concepts, and learning about career opportunities in bioinformatics. Faculty have benefited by "cross-training" on the use of bioinformatics tools, increasing knowledge of content in other related courses, and peer review of their exercises and course content. We believe this project serves as a model for other faculty desiring to comprehensively incorporate bioinformatics into their curriculum.

14-B
Developing Writing Skills in Science Undergraduate Education by Utilizing a Multi-level Library Research Project

Karen M. Smith. University of British Columbia, Vancouver, BC, CANADA.

Large classes, electronic quizzes and multiple choice testing preclude today’s undergraduate students from practising science-writing skills. Curriculum designed for introductory survey courses can lack detailed analysis of microbiology topics and the promotion of science research. Student populations that are highly skilled Internet users are often deficient in utilizing library indexes and searches. To promote library research and investigative reports, students are provided with a semester-length library research project. Subject matter is based on an in-depth analysis of course topics and concepts in prokaryotic cell biology. Students complete 3 written reports where the developed knowledge base increases in complexity. An on-line library tutorial is accessible via the WebCT course management system. This introduces 7 modules with emphasis on types of literature, annotations and citing references. The primary report consists of a thesis statement as to the area of investigation and includes background research. Students identify popular and scholarly sources yet focus on general textbooks and science encyclopedias. By mid-semester, an annotated bibliography is required where students use scholarly research to expand upon on their thesis statement and students assess the value of their sources and information. Final project reports are summaries, the accumulation of first 2 reports. Peer review sessions provided students with the opportunity to read and evaluate other projects. Students identified the library tutorials as experiential and valuable. Many did not recognize that integration of reports was key to their progress. Collectively, reports demonstrated improved writing skills. Finally, plagiarism was addressed by increasing students’ comprehension of literature citation methods.
Building Small-Group Social Skills in College Classrooms

Michele D. Zwolinski and Stephen C. Nold.
University of Wisconsin–Stout, Menomonie, WI.

Social skills, such as communication and trust, promote positive small-group interactions in the college science classroom. Skills, however, are learned. Like using a microscope or a pipette, students need to understand, practice, and assess their social skills when working in groups. Twelve group skill-building activities, or “skills stations”, were designed and assessed in an Introductory Biology laboratory course. These stations are short, modular, customizable, and easy to implement. We emphasized skills such as professionalism, communication, trust, constructive criticism, and encouragement. Two treated and two control laboratory sections, taught by the same instructor, were used to test the effect of skill stations on student performance. Student grades based on quiz, lab, and exam scores were not affected by using stations. However, subtle differences were seen in a pre/post survey of students’ attitudes toward learning biology. Sections using the group skills demonstrated a greater positive shift on survey items related to group work than the control sections. Classroom observations, instructor comments, and student course evaluations indicate that the stations benefited group interactions, created an interactive classroom environment, and decreased student reliance on the instructor. However, instructors do need practice in administering the skill stations and in creating interdependence within groups. Our observations helped to identify areas for improvement and the skill stations were modified for future semesters. We also developed stations skill stations that address knowledge acquisition and are presenting these in a second poster: “Skill Stations Develop Student Skills in the Science Classroom, S.C. Nold and M.D. Zwolinski”.

Presentation times:
#-A – 7:00-7:45pm
#-B – 7:45-8:30pm
#-C – 8:30-9:15pm

Bold - Submitting Author
*Travel Grant Recipient
16-A
The Training of Undergraduate Science Majors in Virological Techniques: Research Application to Anti-viral Activity by Comestible Juices.


Many undergraduate microbiology courses often present exercises in bacteriophage biology. Two motivated students were selected to identify the feasibility of incorporating animal virology into the undergraduate research/classroom settings. Students performed all investigational techniques and manipulations followed by mandated research reports. Virological techniques were utilized to investigate the occurrence of anti-viral activity within commercially available juices. Studies using coliphage T4 revealed a virus inactivation of >7log10 after a <10 min. exposure to cranberry juice (CJ). After a <60 min. exposure to orange (OJ) and grape juices (GJ), phage infectivity was reduced by 20%. CJ inactivation of phage T4 was dose dependent.

Inactivation of T4 occurred at both 4 and 23°C. The phage T4 inactivation rate remained unchanged after an incubation of 18 h at 23°C. Electron microscopy failed to detect adsorption of CJ-treated virus to its host cell. Simian rotavirus SA-11 was grown in MA-104 cell cultures. A modified hemagglutination assay was performed to determine rotavirus activity. Incubation of the rotavirus for 15 min. with an equal volume of CJ resulted in the loss of rotavirus activity. The effect of the CJ on the rotavirus was dose dependent, at a 100 and 50% rotavirus to CJ ratio; CJ concentrations of 13 and 25% had no effect on the virus. Bacteriophages and specifically animal viruses, may be used in both the research and teaching settings at the undergraduate level.

17-B
From Soil to Sequence: A Convincing Demonstration of the Predominance of Uncultured Bacteria in a Soil Sample

Christopher J. Distel and Gerald L. Kreider. Albright College, Reading, PA.

Based on traditional characterization methods, it has long been accepted that marine, aquatic and terrestrial ecosystems exhibit rich microbial diversity. Application of newer molecular approaches, based largely on the uniqueness of 16SrRNA genes, has led to the observation that these ecosystems are characterized by the presence of a far greater number of microorganisms than previously expected. If this is true, we predict that application of techniques currently available in most microbiology labs should directly demonstrate the relative abundance of uncultured bacteria in environmental samples. In this study, DNA was extracted from microorganisms in less than a gram of soil, a segment of its 16SrDNA genes amplified, and the mixed amplicons cloned and sequenced. After BLASTn (GenBank) analysis of all sequences, virtually all had the highest (>95%) sequence homology with GenBank records for uncultured bacteria vis-à-vis those with specific genus and species names. For each evaluated sequence, the GenBank record was unique. We interpret this to mean that (1) there are sufficient records for uncultured bacteria in GenBank to allow this type of project to be done and (2) that an uncomplicated procedure can allow students to convincingly demonstrate the predominance of uncultured bacteria in soil. This approach provides a way to both introduce several common molecular techniques and reveal a fascinating aspect of microbial diversity to undergraduate students.
18-C
Identification and Characterization of *Staphylococcus aureus* and Virulence Properties in the Teaching Lab Using Commercial Test Kits

Beverly A. Dixon¹, Lynn Benjamin¹ and Kevin Mangan*. ¹California State University, Hayward, CA and *Denka Seiken Co., Ltd., Tokyo, Japan.

*Staphylococcus aureus* is recognized as a primary pathogen for producing serious infections, and diseases including food poisoning, toxic shock (TSS) and scalded skin (SSS) syndromes by the elaboration of potent exotoxins. Additionally, methicillin-resistant *S. aureus* (MRSA) have become a world wide concern owing to the increasing frequency with which these strains are implicated in nosocomial infections. For these reasons, the rapid and accurate isolation and identification of *S. aureus* are critical components in the teaching of advanced level microbiology. Following a 3 day protocol, students in a teaching laboratory isolated, identified, and characterized 35 known and unknown isolates of *S. aureus* using selective and differential media, and determined antibiotic sensitivities. Isolates further were characterized for methicillin resistance, coagulase type, and production of enterotoxin, exfoliative and toxic shock exotoxins using commercialized diagnostic kits from Denka Seiken, Tokyo, Japan. These samples showed a distribution of coagulase types I through VIII (excluding types VI and VIII) One new MRSA strain was characterized from the unknown isolates. Toxic shock syndrome toxin (TSST-1) was found in three additional isolates. A total of eleven isolates showed a significant enterotoxin titer, form A, B, C, or D. None of the strains demonstrated the exfoliative toxin A or B. The protocol was easily incorporated into the laboratory exercises and provided students with a broader experience and understanding of pathogenic bacteriology and phenotypic methods for epidemiological typing purposes.

19-A
Integrating Scientific Inquiry, Molecular Biology, and Service-Learning into an Undergraduate Environmental Microbiology Laboratory

Milutin Erbeznik. Albion College, Albion, MI.

Poor water quality of Rice Creek, a Kalamazoo River tributary near Albion, has raised citizens’ concerns, leading to EPA-funded interdisciplinary research performed by Albion faculty and students. A semester-long independent research project has been developed for the laboratory component of an undergraduate Environmental Microbiology course in which students, working in teams of two or three, learn and apply traditional and molecular microbiology techniques to identify bacteria they isolate from Rice Creek, and thus contribute to a comprehensive characterization of the creek’s health. In the first half of the semester, each team attempts to identify an unknown bacterium based on morphological and physiological features, and summarizes this work in a research paper. Then teams design and carry out experiments to verify the identity of their unknowns by a molecular approach: a 16S rRNA gene fragment is PCR-amplified, the amplicon sequence is analyzed via BLAST, and partial phylogenetic trees are also constructed. At the end of the semester, each group presents their entire project in poster form. Some of the sequences obtained so far shared 99% identity to the 16S rDNA from *Pseudomonas aeruginosa*, *Bacillus pumilus*, *Aeromonas veronii*, and *Klebsiella oxytoca*, all potential pathogens found in polluted freshwaters. According to course evaluations, students highly appreciate 1) the independent nature of the project in which their unknowns are also unknowns to the instructor, 2) the opportunity to learn molecular biology techniques, and 3) the sense of association with the community via an environmental project concerning a real-world problem.
20-B
Gene Hunters: A Semester-long Project for a Course in Biotechnology

*Mary B. Farone and Anthony L. Farone. Middle Tennessee State University, Murfreesboro, TN.

Many laboratories designed to teach students techniques in biotechnology often use stand-alone exercises to introduce skills such as polymerase chain reaction (PCR), gene cloning, plasmid purification, and agarose gel electrophoresis. Although individual exercises can be effective, we have observed that students are more interested in projects that they can continue throughout the course. For a 3-credit hour course in biotechnology, we have developed a project that appeals to the wide variety of biology students in the class. For the project, each student begins by isolating bacteria from a source of interest on trypticase soy agar or sheep blood agar. The students choose one or two colonies and begin their identification of the bacteria by a gram stain and biochemical identification using a miniaturized identification system. The students continue identification at the molecular level using PCR and universal primers to amplify the 16S rRNA gene from boiled colony. PCR products are analyzed by agarose gel electrophoresis and ligated into a PCR plasmid cloning vector. The students then transform competent E. coli cells and choose transformants for plasmid purification. The plasmids are checked for insert by PCR and restriction analysis. Sequencing reactions and gels and performed on the plasmid inserts and compared to GenBank sequences, familiarizing the students with the use of genome databases and BLAST. They are then able to compare the identity of their gene sequence to the biochemical identity of their organism.

21-C
Comprehensive Immunological Laboratory Exercises


A series of laboratory exercises have been designed to ensure that Microbiology Undergraduate Students at the University of British Columbia become familiar with practical applications of immunological concepts. The techniques used include, tissue culture, immunoprecipitations, PAGE, Westerns, ECL detection of antigen, nitric oxide (NO) assays and ELISAs. Students used lipopolysaccharide (LPS) to stimulate the murine macrophage cell line, RAW 264.7 to produce the cytokine, TNF alpha in addition to the inducible form of nitric oxide synthase (iNOS). This enzyme synthesizes the oxidizing agent NO. The effect of including Interferon gamma with LPS was also examined. RAW 264.7 cells were stimulated with LPS +/- IFN gamma and at appropriate time intervals, media supernatants and cell lysates were harvested or prepared.

TNF alpha was quantitated in media supernatants using an ELISA and likewise NO concentrations were determined using Griess Reagent and measuring the A595. Immunoprecipitations were performed on cell lysates using anti-iNOS antibody. Released antigens were subjected to SDS-PAGE followed by the Western Transfer Protocol. Incubation with the appropriate antibodies and ECL substrate confirmed the temporal production of iNOS. Approximately 90 % of the class obtained acceptable results for all of the experiments. The ELISA posed the greatest challenge in terms of time management as well as producing useable data. Students presented and discussed their results in a formal lab report. This report provided an opportunity to explore the challenges of the techniques used. The student was also encouraged to reflect on how they might improve on future experimental results. The class, comprised of 63 students, recognized the scientific value of performing an integrated series of experiments over the five week period.
22-A
Microbial Diversity in Great Smoky Mountains National Park: A Tool for Teaching Microbiology through Traditional and Modern Approaches

Seán P. O'Connell. Western Carolina University, Cullowhee, NC.

One of the greatest repositories of global biodiversity exists in Great Smoky Mountains National Park. Long renowned for incredible plant and animal species richness, the Smokies are being investigated for smaller life forms occupying many unique niches. To help define prokaryotic diversity in the Smokies, Western Carolina University has been involving microbiology students in the study of resident microflora. Over sixty students have collected soil and water, isolated heterotrophic bacteria, and characterized these microorganisms. Thirty-six genera representing 63 bacterial species have been identified using 16S rDNA sequences (Ribosomal Database Project II matches ranging from 40.7 to 98.5%). Each student masters the tools that microbiologists use, including microscopy (Gram and negative staining), cultivation (Enterotube screening, environmental tolerances of pH, NaCl, and temperature), and DNA extraction, PCR, and sequencing. This is a semester-long endeavor that is summarized in a term paper modeled after a scientific article. In perfecting the skills of microbiologists, the students learn how to differentiate bacterial species and interpret their findings. They also contribute to real science, as their results are added to the RDP II and GenBank and contribute to a growing list of species found in the Smokies. Students with deeper interests in microbiology have gone on to more extensive research projects, including cave explorations, successful searches for extremophiles (including thermophiles, alkaliphiles, and halophiles), and work with the Archaea. These sorts of activities have done well not only to broadly educate science majors, but have also helped students find employment or entrance into graduate programs.

23-B
Creation of Laboratory Exercises for a Non-majors Course in Bioterrorism

John R. Phythyon, Candice Leach, and Naomie Kraus. St. Norbert College, DePere, WI.

The creation of laboratory exercises that can safely serve to enhance the learning experience of students with limited background in scientific methods requires careful planning. The subject of bioterrorism is a growing area and, while there is much material in print about the subject, there are very few laboratory exercises that relate to the subject. The team constructing the laboratory exercises for this course consists of the lead instructor (Phythyon) and two undergraduate biology majors. This team composition allows for input by two different generations and two points of view regarding the usefulness of each exercise in terms of student learning. We intend to develop laboratory exercises which illustrate the important issues in bioterrorism while also educating non-science majors in the basic principles of microbiology (1) how microbiological agents can be spread among a population, and how quickly; (2) the mechanism of action of selected bacterial and viral agents; (3) the methods used to create biological weapons; and (4) methods for prevention of spread. Since this is a course open to non-biology majors, a major emphasis will be to create labs that can be done effectively and safely by non-science majors. The effectiveness of these laboratory exercises will be measured by pre- and post-assessment instruments in which the students give feedback on the exercises. This course, consisting of 6 lecture/laboratory hours per week, is being offered during the Spring 2004 semester. Our poster will include all the exercises developed and the assessment devices generated. We will also include an analysis of the student feedback.
24-C
Bioluminescence Workshop - To Study the Detection and Regulation of Bacterial Lux Gene Expression


In teaching Microbial Genetics, we run a bioluminescence workshop that encourages students to work in groups and plan their own experiments. The workshop, with Vibrio fischeri, uses the example of lux genes to show how bacteria regulate genes in response to cell density (quorum sensing).

Aim: To use collaborative group work to investigate the detection and control of bioluminescence

Objectives:
1. Team planning of experiments to investigate the tasks set
2. Carrying out experiments, recording results and analysing class data
3. Verbal group reports to the class

Each group is set 2 tasks which they have to solve by discussion, planning and then experimental work:
A. What % of V. fischeri colonies on the supplied BOSS agar plate show bioluminescence? Is it uniform throughout the colony?
B. Can you demonstrate that lux genes in V. fischeri are controlled by an autoinducer?

Each group gives a brief verbal report after planning their experiments for each task. For task A, groups usually decide to photograph the plates in the dark. For task B, at least one group realises that growing V. fischeri with and without culture filtrate will indicate a diffusible autoinducer. An experimental protocol is then provided and bioluminescence is measured in a single tube luminometer. Each group obtains a set of quantitative results which are collated for the whole class and analysed.

Outcome:
Students discover how bioluminescence is measured and controlled, how to work successfully in a group and how to formulate and deliver a group report.

25-A
A New Twist on Bacterial Unknowns: St. Patho General Hospital

Patty Shields. University of Maryland, College Park, MD.

In our upper level Pathogenic Microbiology class, we have used the standard practice of identification of a clinical unknown to assess student understanding of the procedures and media used in the study of pathogenic microbes. However, we noted that many students were unable to relate relevant and critical lecture content to the exercises conducted in the laboratory. To more deeply engage the students in their own learning and aid them in connecting lecture concepts and lab content, we developed an assignment called “St. Patho General Hospital”.

Students were required to act first as physicians in the clinical setting and then as technicians in a hospital microbiology lab. Each student was given a clinical unknown that consisted of a mixed culture contained in artificial clinical substance and was assigned a patient to interview. Each “patient” assumed a different identity and was given appropriate background information as well as a list of signs and symptoms for their given illness. The “practical goal” was for students to isolate and identify the causative agent of disease. Additionally, the project was set up so that successful completion of the practical goal could only be obtained by linking information learned in the lecture to information learned in the laboratory.

Students indicated that assuming the role of a physician forced them to relate information about pathogenesis obtained in lecture to the hands-on information they obtained in lab. We found that a majority of the students were highly motivated in spite of the fact that the mixed cultures increased the probability of not isolating the causative organism. Additionally, the quality of the lab reports improved and many students reported that they thought the exercise had helped them to understand the material more deeply.
Critical Connections: Facilitated Learning Through Interdisciplinary Undergraduate Research Involving Retrospective Epidemiological Studies and Memories of Older Adults of Influenza (1918) and Polio (1940-1960)


Quality of education in the 21st century increasingly demands academic boundary crossing. Two studies aimed at teaching students of Virology, Nursing, Psychology, Anthropology, History, and Radio/TV/Film the way in which viruses affect whole communities (epidemiology) were conducted via multiple discipline investigations. Virology student research involved the examination of archival resources including census records, death records, military resources, newspaper obituaries, articles, diaries, and oral histories. Anthropology students performed a cemetery field survey to study American mourning practices. Psychology, Nursing, History, and Radio/TV/Film students interviewed Influenza or Polio survivors, nurses and physicians who treated Polio patients. An Internal Review Board (IRB) approved all interview protocols. The Oshkosh community responded enthusiastically to the project. College students often fail to make connections among classes they take, especially in institutions that do not clearly articulate the value of liberal arts education. These projects created two "liberal arts laboratories." Students commented that these cross disciplinary studies which integrate faculty, students and the community, made complex topics about viral diseases lucid and interesting. They help to justify the need to understand the pathology and molecular biology of viruses. Positive feedback indicates that the concept behind these projects provides a useful learning experience that can be adapted to other programs.

Creation of a Bioinformatics-driven Microbial Molecular Genetics Laboratory

Michael L. Summers. California State University Northridge, Northridge, CA.

Due to the data provided by an increasing number of sequenced bacterial genomes, there is a growing body of literature that uses bioinformatic tools to predict gene function and regulation. Using such a paper (Ochia de Alda and Houmard, Microbiol. 146:3183), a semester-long laboratory was designed for an upper-level Molecular Genetics of Microorganisms class. This paper identified 12 putative cyanobacterial genes under Crp (cAMP receptor protein) control due to the presence of near-consensus Crp binding in their upstream regions. The goal was to test if this set of genes were in fact regulated by Crp. Students designed primers, conducted PCR, and cloned promoter regions into a GFP (Green Fluorescent Protein) transcriptional reporter plasmid. The reporter constructs were transformed into both Escherichia coli and cyanobacterial hosts, and reporter activity was measured under conditions where Crp was active and inactive. To determine if regulation was Crp-dependent, the experiment was also conducted in parallel using a similarly transformed crp mutant strains. Inclusion of the fast growing E. coli host enabled the class to test a second hypothesis; due to an identical binding site proposed for the E. coli and cyanobacterial Crp homologues, the E. coli Crp could regulate the cyanobacterial gene's promoter. Students gained meaningful lab experience that reinforced concepts presented in class such as DNA isolation, recombinant DNA technology, transformation, recombination, gene regulation, as well as sequence retrieval and manipulation. Although questions will vary, this approach can be adapted to any sequenced microbe and produce a potentially publishable unit of experimental research.
28-A
Learning about Microbial Diversity through a "Microbe Collection"

Debra L. Wohl. University of Richmond, Richmond, VA.

Under the guidance of the simple adage "learning is by doing", biology majors at the University of Richmond taking a general microbiology course spend the semester creating a "Microbe Collection". Each student receives a diversity workbook at the beginning of the semester. The diversity workbook provides basic background and methodological information on the 20 microorganisms they are expected to isolate during the semester. Collection techniques include Winogradsky columns, selective media, and bait traps. The semester-long project aims to instruct students on the wide array of microorganisms and diversity inhabiting commonplace environments. During the semester, a record of each student's collection is kept tracking each organism they have successfully collected. Student evaluation of the collection is determined by a point scale based on the weighted value of each organism (e.g., an agar digester is worth 5 pts, whereas Photobacterium is worth 15 pts). As evidenced through their technique, exam scores and student evaluations, this semester long "Microbe Collection" gives students confidence and expertise in collections, enrichment cultures, microscopy and other techniques, as well as an appreciation of microbial diversity.

29-B
Teaching the Identification of Microbes: Traditional and/or Molecular

Penelope Worthington and Paul Blum. University of Nebraska-Lincoln, Lincoln, NE.

Microorganisms are all around. One of the important tasks for any teacher in a microbiology lab is to teach students techniques and methods that can be used to identify these microorganisms. Computer programs can aid in this task and offer a variety of organisms available for identification. The major drawback of many of these programs is that they are designed for clinical microbiologists and therefore concentrate on pathogenic microorganisms. Many more organisms are non-pathogenic than are pathogenic. In fact many of these non-pathogenic organisms play vital roles in daily life. Learning to identify industrially important organisms and those that are interesting because of their environmental niche is also valuable. Learning to identify unknown microorganisms by two different methods facilitates this learning process. Most laboratory classes are very good at teaching techniques to students. The use of unknown identification projects have the added advantages of teaching students how to apply the techniques that they have learned and helping students to understand how different techniques can offer unique opportunities to evaluate the information that results from their efforts.

Two methods are commonly used to identify unknown microorganisms. These methods are 1) the traditional method using physiology and metabolic tests and 2) the molecular method using DNA extraction, 16S rRNA, PCR and BLAST searches. Method one “the traditional” method has a long history of use. After learning metabolic testing techniques using known organisms, students are supplied with a mixture of two “unknown” bacteria. They are then asked to create a scenario in which the organisms that they are identifying are either a) novel species or b) known organisms isolated from a novel location. This enables students to place the organisms that they are testing into context in the environment by incorporating information about habitat and growth requirements as well as metabolic testing into their scenario. The scenarios students created are used as a part of a scientific journal article describing the identification of the species and why the organisms or location are noteworthy. Students are required to include charts and tables outlining the identification process and are encouraged to use graphs, pictures and other potential figures as a part of their paper. Method two is less complex in the number of
Hands-on

experiments required of the student, but requires greater laboratory skill. Each student received a culture or cell pellet identified as an unknown and unculturable environmental sample. The students work through the process of Genomic DNA extraction, PCR of the 16S rRNA gene and preparation of the PCR product for sequencing. Each student then receives a sequence file. This sequence is used by the student for a BLAST search using the NCBI website. Students are asked to identify the organism based on its similarity to the sequences in the database and to use this identity to create a report. Sequences handed out to students include both characterized and uncharacterized species. The challenge in project one is for students to generate experimental data that must be analyzed and in project two for students to retrieve and analyze information that they have not generated that is based on their experimental work.
DYOE (Design Your Own Experiment): A Model for One-Week Independent Laboratory Projects in a Microbiology Course

Jason C. Baker. Missouri Western State College, St. Joseph, MO.

With an increasing emphasis on engaging students in experiential learning, many faculty implement independent research projects into science courses for science majors. However, semester-long projects are often daunting to the student, costly to the institution, time consuming for both the faculty and student, and often hurriedly completed by the student at the last moment to meet a deadline. In order to avoid some of these pitfalls, independent projects lasting one week were built into the laboratory sections of the Microbiology course for science majors at Missouri Western State College. Twice in the semester each team of two students was required to design, perform, and evaluate data for their unique project related to an overall class topic. Each student group was required to present their project to the class in a short oral talk at the end of the week. Assessment data show that students gained substantial independent thinking, logistical skills, found application for the laboratory skills being taught, and greatly enjoyed the opportunity to pursue independent ideas without all the pitfalls of long-term projects and without the cookbook approach of standard lab activities. The unique, one week design of these independent projects helped students develop the independent thinking skills all undergraduate educators desire without the cost, time commitment, and logistical problems of more lengthy projects.

When Engineers and Microbiologists Work Together

Larry Baresi. California State University Northridge, Northridge, CA.

Technical innovations have dramatically altered the practice of medicine. Biomedical Engineering has emerged as the medium combining the fields of science with materials, tools and techniques usually associated with engineering. Biomedical Engineering II is an interdisciplinary course with the goal of acquainting Microbiologist and Engineering students with each other’s methods, skills, and abilities. The course is divided into: introduction, subject overview, application, analysis, evaluation, and submission. Through this sequence students can, by example, familiarize themselves with the evolutionary process of interdisciplinary devise development. Recently subjects covered included the use of bacterially produced magnetic particles for 1) early identification and treatment of lung cancer and 2) development of devices for male contraception and incontinence. On alternating class meetings each group was required to give a progress report on their project with biologist presenting the engineering aspects and engineers presenting the biological aspects. After each presentation critical discussions were undertaken by all members of the class and based on these discussions new data was obtained from interviews, library searches, Internet searchers, and research papers. This material was presented with new proposals being made as older ones were found not to be viable. It was through this process that students discovered how difficult it was to present their ideas to others with dissimilar backgrounds and came to understand that each discipline had something unique to offer and that together viable solutions to the problem could be obtained. Course assessment was completed through the use of ten-question questionnaire. The average score was 1.2 with 1 representing the most positive response on a scale of one to five. In addition, three of the sixteen students also authored letters supporting the continuation of this course to the administration.
**32-B**  
**Environmental Microbiology: A Multidisciplinary, Multi-class Approach**

Brandi Baros, Caryl Waggett, Adrienne Coble, John Krempecki, Guy Dunkle, and Richard D. Bowden. Allegheny College, Meadville, PA.

Biology and Environmental Science (ES) majors often diverge. Outdoor-focused ES majors may be unaware of microbiological laboratory tools. Laboratory-focused biology majors may not connect microbiology with environmental issues. Baros (microbiologist), Bowden (ecologist) and Waggett (disease ecologist) collaborate to help students connect subdisciplines, increasing student interest where subdisciplines converge.

Under faculty guidance, students designed, analyzed and wrote up field/laboratory experiments to examine human impacts on landscape-scale soil organic matter. Biology students quantified soil microbes, assaying nitrogen usage, carbohydrate metabolism, and other aspects of microbes isolated during enumeration. Students found 73% of enhanced-litter plot microbes were culturable on N-free media, compared to only 50% from control plots. Enhanced-litter plots contained threefold more fungi than control plots, which contained twofold more than reduced litter plots. ES students investigated agricultural effects on soil properties by conducting field collections and examining soil properties (C/N content, organic matter, pH, bulk density), and Microbiology students censused soil microbiota. The separate classes will meet at the end of the semester to compare and discuss results.

Several senior theses have also emerged in microbial ecology due to these collaborations. A biology senior analyzed influences of N deposition on microbial biomass and contributions to soil C and N cycling. An ES senior examined soil respiration in the same soils.

These students share data, enhancing comprehension of their own projects. Students understood the value of interdisciplinary approaches toward natural resource issues. Future students will further these experiments, creating projects investigating soil microbiology and microbial involvement in ecosystem processes.

---

**33-C**  
**Incorporating an Inquiry-based Culminating Project into a Bacterial Diversity Course**

B. Bratina and M. Winfrey. University of Wisconsin-La Crosse, La Cross, WI.

The trend in science education is toward laboratory exercises that are inquiry-based rather than standard "cookbook" exercises with a preordained outcome. Additionally, a culminating project that incorporates a variety of skills and concepts aids students in applying what they have learned throughout the course. Bacterial diversity and environmental microbiology courses lend themselves ideally to this type of inquiry-based, culminating project. In our Bacterial Diversity course, each pair of students is required to select a non-pathogenic organism that they will attempt to isolate from an environmental sample. Once they get the organism approved by the instructor, they then research their organism and write up an enrichment and isolation proposal describing their intended inocula and its method of collection, media required and how they intend to proceed to isolate their organism. The students prepare their own media, collect samples, and attempt to isolate the selected organism using their approved protocol. Isolates may be identified using 16S rRNA sequence analysis to ascertain the success of the isolation. The project is completed with each pair of students giving an oral presentation on their organism and the attempted isolation. This project (1) requires students to do literature research, (2) allows students a chance to gather environmental samples, (3) tests students' isolation techniques such as streak plating, (4) introduces students to the use of bioinformatics and (5) develops students' written and oral communication skills. Student feedback indicates that this project enhances student confidence and that students enjoy the opportunity to work independently.
34-A
Biodegradation of Plastic Bags: A Cross-Disciplinary Project for Students in Microbial Ecology, Chemistry, Material Science and Environmental Studies


Alfred University students are taking part in a multi-disciplinary laboratory project exploring multiple biological and environmental influences on the degradation of plastic bags (polyethylene and starch), which is influenced by UV and bacterial exposure. Students in four courses contributed participated: Material Science students studied the modified polyethylene; Chemists examined the surrounding water; Environmental Studies students looked at surrounding soil; and Microbial Ecologists looked for changes in bacterial community structures which may result in degradation changes. The Microbial Ecology students used several techniques for analysis, to gain an understanding of the advantages and disadvantages of different methods of bacterial community analysis.

Samples of the plastic were buried in two groups, depending on composition, 10 inches deep for 22 months in a pit on the Alfred University campus. Half of each sample protruded from the soil and was exposed directly to the elements. After the exposure, Microbial Ecology students collected, bulked, and sieved random cores from each of the two sample groups. Sample cores were analyzed for viable bacterial counts on rich media as well as defined media incorporating bag polymers to look for organisms directly capable of utilizing the bags as a carbon source. Students analyzed and compared community structure by examining carbohydrate utilization patterns with Biolog's Microlog 3E station. Finally, genomic DNA was isolated from the samples and used for T-RFLP analysis. Results from the bacterial degradation were shared with data from the students in the other courses to provide a complete picture of the degradation process and environmental effects.

35-B
Original Research Conducted within Instructional Biology and Chemistry Laboratories at Eastern Michigan University

Daniel Clemans1, David Kass1, Elizabeth Butch2, and Steven Pernecky2 1Departments of Biology and 2Chemistry, Eastern Michigan University, Ypsilanti, MI.

Inquiry-based laboratory exercises in genomics constitute a new integrative pedagogical strategy at Eastern Michigan University. This unique experience centers on DNA sequencing and analysis, and involves the design of research projects within existing laboratory courses in Biochemistry, Recombinant DNA Technology, Microbial Physiology, and a new course in Genome Analysis. The research in the latter course entails DNA isolation from cheek cells of students for DNA fingerprinting projects. A database will be constructed where students can incorporate data to do comparative studies of allele frequencies among groups and perform analyses in population genetics. A site-directed mutagenesis project in the Biochemistry lab is in development to investigate the structure-activity relationships of the drug metabolizing enzyme cytochrome P450 2B4. Students use the available three-dimensional PDB structure via Protein Explorer and literature information to propose site-directed mutagenesis studies to investigate the function of relevant amino acid residues. A collaborative approach involving two instructional laboratories is in development as a model for inter-disciplinary training in the life sciences. For example, two of the projects in the Recombinant DNA Technology course were devoted to cloning the DNA for oxidant enzymes from white rot fungi and human epithelial cells. These cloned enzymes will then be used in instructional Microbial Physiology and Biochemistry laboratories to develop bacterial systems for expression, purification, and characterization of the enzyme. A larger goal of faculty within the biology and chemistry departments is the development of an integrated laboratory sciences program built around a novel research theme, so that students in diverse sub-disciplines within chemistry and biology will discover the relevance of multi-disciplinary approaches. Supported by NSF CCLI grant 0126640.
36-C  
Fecal Contamination Source Tracking Using Discriminant Function Analysis of Antibiotic Resistance Patterns

M.A. Mills and M.A. Furlong. Clayton College and State University, Morrow, GA.

Fecal contamination of watersheds is a growing concern in urban regions and source-tracking this contamination has become a priority. Previous studies on fecal contamination source-tracking in large watersheds have shown discriminant function analysis of antibiotic resistance patterns to be useful in differentiating fecal coliforms and enterococci from various animal sources. A smaller watershed in the Metro Atlanta area is the focus of this study. The data indicated that 62% and 92% of the isolates from human sewerage and wild animal feces, respectively, can be correctly classified. When the isolates from water samples were compared to the database of human and wild animal fecal isolates, it appeared that 40% were classified as being from human sources and 60% were classified as being from wild sources.

All Biology majors at Clayton State are required to complete at least one semester of independent research, which must be presented to the natural science faculty. A faculty mentor initially planned this research project, which was completed by an undergraduate biology major during summer term. The project was introduced to introductory microbiology students, in the spring, as a laboratory lesson on water quality testing. Introducing research projects in such a way provides the opportunity to recruit students into a project, train them on how to perform the actual techniques before their research term begins and introduce inquiry-based methods into the microbiology laboratory curriculum.

37-A  
Integration of Student Independent Investigations into the Syllabus of an Applied and Environmental Microbiology Course as a Means to Encourage Interest in Microbiology Research

Richard T. St. John. Widener University, Chester, PA.

Students in an Applied and Environmental Microbiology course were required to choose a specific microorganism to isolate from the environment. A list of suggested organisms and initial isolation schemes were provided. Upon successful isolation, each student was required to design an investigation of the metabolism of the microorganism. Students were responsible for hypothesis construction, experimental design, preparation of culture medium, etc. Two of the students chose to continue their projects as independent study research during the following semester. This report will detail their isolations, initial investigations and the progress of their Independent Study projects.

One student isolated a soil bacterium that degraded the insecticide Sevin® (carbaryl). She succeeded in isolating a pseudomonad that could utilize the insecticide as its sole carbon source and designed an HPLC method for quantifying the consumption of carbaryl in a broth culture medium. This student plans to determine if any of the genes involved in the initial breakdown of carbaryl are located on plasmids. The other student isolated an antibiotic-producing soil bacterium, tentatively identified as a species of Arthrobacter. Plugs of agar cut from streak plates of the bacterium were applied to Kirby Bauer Antibiotic Sensitivity Assay test plates spread with a number of different bacteria and yeast. The antibiotic was determined to have a narrow spectrum of activity against only gram positive bacteria. She further characterized the analyte properties of the antibiotic by its affinity to various Solid Phase Extraction (SPE) sorbent columns. Results suggest that the antibiotic is an amphipathic molecule.
38-B
Exploring the Diversity in Aerobic Bacterial Communities of Polluted Yamuna Waters and Comparing it with an Adjacent Institutional Area - An Undergraduate Project

*S. Krishna Sundari.* Jaypee Institute of Information Technology (JIIT) Noida. U.P., INDIA.

The river Yamuna that accounts for more than 70% of Delhi’s water supplies and caters to the daily needs of 57 million people is reportedly under threat of pollution due to a multitude of factors. Habitat is one of the primary factors determining the resident microflora. In this study we aimed at exploring the diversity of bacterial communities from polluted waters of Yamuna and comparing it with the profile of bacterial community from adjacent Institutional area. Three different sample types were studied. 1. Water samples from Yamuna, storage tanks, stagnant water bodies in the vicinity & water treated for domestic use, 2. Soil samples from river bank, adjacent natural vegetation, nursery soil & soil from dumpsites and 3. Root samples of various plants that are growing in the respective sampling areas. Mixed bacterial consortia were cultured on LB agar and LB broth. A battery of microscopy tests was conducted to identify bacterial colony morphology, cell morphology, presence or absence of capsule, and motility. The ability of the bacterial communities to degrade specific carbohydrate substrates (glucose, fructose, lactose), and to show enzyme activities (amylase, protease, catalase, urease) was tested and the results were correlated to the nature of habitat from which they were isolated. Response curves of the bacterial communities with respect to metal concentration, organic compounds, pH and temperature were closely studied. The possibility of acquired resistance in the bacterial communities from polluted soil and water samples to higher concentration of metals and organic substances is debated in the study.

A team of undergraduate students were involved at every facet of project execution right from the conceptualisation of project theme, literature review, sample collection, rigorous bench work, data analysis and trouble shooting. The performance of each individual is rated on the basis of continuous faculty interaction, ability to propose new ideas, apart from the tangible deliverable, emergence of task specific leadership, personal feed back forms, test for aptitude before and after commencement of the project and confidential peer rating. The group also made a project report and presented their work in front of the departmental committee.

39-C
The Resistance Movement - Antibiotic Resistance of Inland Waters in Southeastern Michigan

*Bridgette West.* Eastern Michigan University, Ypsilanti, MI.

Waterborne disease outbreaks associated with rivers, ponds and lakes occur as a result of water pollution. Pollution of water can be attributed to the contamination with coliform bacteria, most of which are from the Enterobacteriaceae family. These bacteria are commonly found in the gut and feces of warm-blooded animals and their presence in water may indicate contamination with human and/or animal feces. Water is tested to detect coliform bacteria, because the higher the fecal coliform count, the higher the probability there is to contract a disease from the water. We are beginning to see an emerging pattern of resistance among aquatic, environmental bacterial populations in proportion to increasing use of both therapeutic and non-therapeutic antibiotics. In many school science classes, there is a disconnect that exists between science in schools and science in industry. In order to incorporate real science into school science, educators can use a problem-based learning (PBL) technique. Lessons taught in real world context increases student interest and raises awareness of subjects that can impact their lives. The main benefit of PBL to students is developing an awareness of the connection between science and society. This research uses a protocol to test for antibiotic resistance as a problem based lesson for introductory microbiology students at Eastern Michigan University. Students gather water samples from lakes or rivers of their choice to test. The students then use the experimental protocol to test their water samples for any conjugative, antibiotic resistant bacteria. Pre-and post-assessments are performed to determine knowledge level. Upon comparison of pre- and post-assessments, a gain in knowledge was indicated.
40-A
Developing a Research Program for Widespread Undergraduate Participation: Phylogenetic Typing of Cultivated and Uncultivated Microflora of Soil Communities


We have developed a program for use in universities that will enable undergraduates to participate in cutting edge research and to experience the thrill of discovery within a short time of starting. The program is multidisciplinary, exposing students to microbiology, bacteriology, bioinformatics, genomics, and eventually biochemistry and organic chemistry. We have streamlined protocols that allow starting undergraduates to isolate DNA directly from the soil or from cultivated microorganisms, PCR amplify the 16S RNA gene segments, and build phylogenetic trees based on the sequence results of the amplified DNA. In a subsequent stage, students identify antibiotic producing microorganisms and characterize them and their products more fully.

With a number of starting undergraduates we have collected soil samples from various sites around the UCLA campus, including a botanical garden. The microbial communities were examined either by cultivation or through molecular techniques. DNA was isolated both from cultivated strains grown on different media, and directly from the soil without cultivation. Sequences were acquired using universal primers specific for eubacterial 16S RNA. We were able to classify phylogenetically distinct microorganisms, including those that were previously unidentified, using the Ribosomal Database Project Phylip Interface, and also the Clustal W website. These results allow a visualization of the diversity of microbial soil communities drawn from different microenvironments. First year students can go from the collection of soil samples to the generation of phylogenetic trees in as little as two weeks.

We have judged the program to be highly successful, based on the fact that undergraduates have been enthusiastic, and have accomplished many things in a short period of time. They have been stimulated by their own results to continue on in research.

The feedback from the first group of students has been unanimously positive.
41-B
Can Local Health Care Agencies Safely Handle Biological Terrorism Microorganisms?

Jameel Al-Dujaili, Marlene Foreman, and Melanie Foreman. Louisiana State University at Eunice, Eunice, LA.

The purposes of the study was two-fold: 1) to encourage undergraduate participation in research through the LSUE Undergraduate Research Summer Institute (URSI) Project, and 2) to study local health care agencies’ ability to handle microorganisms that may be used in biological terrorism. The researcher team accomplished these purposes in Summer 2002. The team developed a survey form to query local health care laboratory personnel regarding safety protocols for handling specimens that may contain microorganisms of biological terrorism and the decontamination solutions used. Laboratory personnel of selected area health care agencies were interviewed to determine protocols and to obtain samples of decontamination solutions used. The team used the Phenol Coefficient as the standard to compare the effectiveness of Clorox, Virex, and Matar (the three most common chemicals used by the health care agencies surveyed) in killing laboratory samples of Bacillus megaterium (similar to Anthrax) and Staphylococcus aureus. Two flasks of nutrient broth were inoculated with either Bacillus megaterium or Staphylococcus aureus and allowed to grow for 48 hours. Various dilutions of the chemicals were placed in marked test tubes which were then inoculated with 0.5 ml of each bacterium. After 48 hours, the tubes were observed for growth and results recorded. These results indicated that the concentrations of solutions used in some of the institutions were too weak to adequately kill microorganisms that could be used in biological terrorism. The researchers recognize that further study related to effectiveness of chemicals used in health care agencies is indicated.

42-C
Microbiology for Teachers: The Trickle Up Effect. A Course for High School Educators

Veronica Little and Benjie Blair. Jacksonville State University, Jacksonville, AL.

Jacksonville State University has developed a graduate course in microbiology specifically designed for students pursuing a masters in education degree. It offers participants an understanding of microbiological processes in a format that is immediately useful for classroom exercises and lectures. The course is separated into three main focus areas; 1) resource availability 2) overview of microbiology and 3) application to lesson plans. Resource availability introduces teachers to careers in microbiology, methods of advising students interested in these fields of study. Physical resources such as internet sites and partnerships with the “Alabama Science in Motion” project and/or JSU’s microbiology faculty are discussed. Basic concepts of microbiology are then reviewed using individual student lecture presentations, which are pooled to provide each participant a copy of multiple lectures/lecture materials. States are now requiring specific curriculum topics to be covered in high school classrooms, which allows very little time for extra lesson plans. The third focus of this course incorporates microbiological concepts into related biological topics mandated by state curriculum requirement. Participants were tested immediately following the course and at least 1 year after taking the course using an attitudinal survey. Of the 29 participants to have finished the course 27 responded with an overwhelmingly positive feeling for the usefulness of the class and perhaps more importantly they have been using both lectures and laboratories obtained during the course in their high school classrooms. Some incoming freshmen students at JSU are now entering with a strong background in microbiology. The trickle up effect.
**Outreach**

**43-A**

**Learning Through Teaching in a Non-Majors Microbiology Class**

Heidi Elmendorf. Georgetown University, Washington, DC.

Many students begin and end their college careers disenfranchised from science; yet they will encounter science daily in their lives through health, environmental and technology issues. My project explores how teaching science can instill confidence, enthusiasm and disciplinary understanding among non-science majors. In particular I am interested in how student learning in a teaching experience compares and contrasts with a more traditional laboratory experience. Thus students in one section of my non-majors microbiology course develop and teach hands-on curriculum modules to 4th-6th graders, while students in my other two sections conduct laboratory exercises. A key issue raised by this project is the need to define what expectations we hold for student learning in science courses required as part of a general education curriculum. In such a limited engagement with a discipline, what do we want the students to take away? What does deep understanding look like in such a context?

I am have examined three aspects of my students’ learning with their permission: (1) Scientific analytic ability through analysis of the changes in my students’ ability to question and evaluate a scientific news article before and after the term; (2) Creativity and independence of scientific thought through extensive videotaped documentation of their work within teams to iteratively develop and refine a science curriculum; (3) Changes in perceptions about science through reflective journals. The teaching experience motivates my students to engage the material with perseverance and creativity so that they can effectively teach and inspire their own students about microbiology.

---

**44-B**

**Microbial Problems in Biocomplexity: Opportunities for Research and Educational Collaboration of Scientists, Secondary School Educators, and Students**

Regina Herrick¹, Luci Levesque², Marjorie Tennyson³, Donald Berthiaume⁴, Gail Fletcher⁵, Christine Tellarini⁶, David Almeida⁷, Karen D. Moulton⁷, Jennifer Jamison⁷, Amanda Andersen⁷, Sonya Hawkins⁸, Kimberly Brothers⁸, Elizabeth Richards⁹, Allison Hopkins⁹, Barry Larman⁸, Beth Hill⁸, and S. Monroe Duboise⁸.¹ Skowhegan Area High School, Skowhegan, ME, ²Capital Area Technical Center, Augusta, ME, ³Hall-Dale High School, Farmingdale, ME, ⁴Portland Arts and Technology High School, Portland, ME, ⁵Western New England College, Springfield, MA, and ⁶University of Southern Maine, Portland, ME.

Biocomplexity research is rich in possibilities for interdisciplinary collaborations in research and science education. Microbial topics are particularly approachable within the constraints of secondary school science curricula. The Maine ScienceCorps, with funding from the NSF Graduate Teaching Fellows in K-12 Education initiative, has partnered University of Southern Maine (USM) immunology and molecular biology graduate students and researchers with teachers at twelve Maine high schools since its inception in 2001. During the past year, the ScienceCorps has initiated a new research project in collaboration with teachers at four schools to bring authentic research problems in biocomplexity into the classrooms. Epizootic lobster shell disease, a polymicrobial disease of ill-defined etiology that degrades the chitinaceous carapace of infected lobsters, has increased in prevalence in southern New England and Long Island coastal waters in recent years causing significant concern for Maine’s lobster industry. Shell disease, a problem in biocomplexity involving complex microbial communities and myriad environmental factors, provides a rich context for interdisciplinary scientific inquiry. USM and Western New England College researchers and students are collaborating with high school teachers and students in development of virological approaches to the study of shell disease. The importance of bacteriophages in the ecology of microbial communities and numerous precedents for their importance in bacterial pathogenicity suggest that study of shell disease from a virological perspective may be interesting. Collaborative effort to isolate and characterize bacteriophages that infect bacteria isolated from lobster shell disease lesions has been the primary focus of the work that will be described.
45-C
A New Generation of Scientific Teachers: Training Graduate Students to Teach

Sarah Lauffer and Jo Handelsman. University of Wisconsin-Madison, Madison, WI.

Graduate students are a key component in the reform of science education at research universities. Through the Howard Hughes Medical Institute (HHMI) New Generation Program, we offer training in "scientific teaching" for graduate students in biology, and we are studying the impact on the graduate students and the undergraduates they teach. Our research is guided by the following hypothesis: Training graduate students to teach and mentor improves the education of undergraduates and the preparation of graduate students for careers in science. To test this hypothesis, HHMI Teaching Fellows learn a scientific approach to teaching by participating in a series of courses that provide hands-on experience in classroom teaching or undergraduate mentoring. Fellows use evidence-based teaching techniques as they acquire the skills to approach teaching in a scholarly, iterative, and practical way. Following the tenets of scientific research, Fellows design teaching experiments in which they pose hypotheses, assess and evaluate data, undergo peer review, and share results in a public forum. We evaluate the impact of the program through carefully designed interviews, surveys, and rubrics. In this poster, we present data from the program and guidelines for replication at other institutions.

46-A
Integrating Traditional Ways of Knowing with Clinical Microbiology

Tina Melin and Kathleen Douglass. Ketchikan General Hospital Laboratory, Ketchikan, AK and Maniilaq Health Center, Kotzebue, AK.

Clinical Laboratory Scientists at the Maniilaq Health Center Clinical Laboratory have teamed up with young scientists of the Northwest Arctic Region to work in the field of Clinical Microbiology. We plan to learn more about the effects of plant and tree extracts on pathogenic bacteria in vitro. We are working with botanical products of distillation testing indigenous plants and trees used locally as well as those from around the world. The young students K-12 are teaming up with Elders, health care providers, teachers, community science coaches and Clinical Laboratory Scientists in the field of research conducted in the Clinical Microbiology Laboratory. We are working together on projects to be shared with the community and at local and state science fairs.

Educators and mentors have found ways to assess the learning process of students participating in this project by evaluating their written comments, their oral presentations and discussions. The students have demonstrated at community gatherings and science fairs that discussions centered around their projects can stimulate scientific inquiry among all ages. They have experienced science in its entirety from inquiry, designing experiments for clinical laboratory research, literature search, compiling data, to submission of abstracts for participation in national scientific conferences.

The students have acquired valuable traditional knowledge from the Elders and community members through their seasons spent outdoors in the arctic wilderness and at camp. We have all heard stories about the uses of plants for healing. The students wish to learn more about the traditional knowledge of plants with regards to helping combat bacterial infections. When we work with botanical extracts, we get an educational experience in indigenous healing traditions, world geography, ecology, science and conservation of our environment.

It is our goal that these concerted efforts may help encourage students at an early age to explore and learn more about the exciting field of scientific research and development. This knowledge and understanding may help improve the quality of life for the communities in which they live. We hope that working together on science projects that integrate the traditional scientific ways of knowing will serve as a foundation that may help turn science to the service of our communities, with a springboard to the future.
**47-B**
The Unexpected Protocol: Combine Urban Youth, Community Outreach and High Through-put Cloning to Achieve Results

C. Mendis, **M.K. Anderson**, D.L. Yourick, M. Jett. M. Walter Reed Army Institute of Research, Silver Spring, MD.

The Walter Reed Army Institute of Research provides urban youth with one month research internships through the Gains in the Education of Mathematics and Science program. This educational internship provides essential microbiology knowledge and skills to pre-college students who have only a cursory acquaintance with laboratory learning. Through participation in an ongoing experiment the students learn basic techniques as well as common laboratory protocols. Their scientific objective is to identify the unknown genes that have been generated by differential display studies of cellular response to microbial challenge. These genes are expected to yield information relevant to cell function, rapid diagnostic tools and possibly result in identifying therapeutic targets. The unknown DNA products were amplified using PCR, analyzed and cloned into a Topo-TA vector (Invitogen). Plasmids from the transformed cell were purified, subjected to restriction assays, analyzed on 1% agarose gels and identified through a sequence facility. The known sequences were then used to obtain the functional relevance of the genes through the EMBL databank. To date, several of the identified genes have had functions that pertain to the disease state as well as several novel genes not yet included in EMBL database. Finally, students prepare a brief literature review and a formal poster. They present their findings during a graduation ceremony each summer. Approximately 100 students have completed the cloning internship. Formal, external evaluations have shown this research initiative has not only given students' knowledge and skills; it has also enhanced their commitment to science.

**48-C**
Service Learning in Allied Health Microbiology

**Marie Panec.** Moorpark College, Moorpark, CA.

Service learning involves students in the application of course content to relevant situations. Studies have demonstrated that service learning can effectively increase both learning and retention of course content. Allied health microbiology courses offer an ideal opportunity for service learning. Most students in these courses plan on a career in the health professions where they will be called on to educate patients and clients. An introductory experience involving students in the education of the public on some aspect of microbiology will serve to reinforce learned concepts while fostering development of essential communication skills.

In this project groups of students were required to identify a message derived from their microbiology course that they wanted to deliver to a target audience in the community. The student groups designed the method that they would use to communicate their message, and then went out to educate their target audience. The target audience varied depending on the message and included students from the general population on the college campus, elementary school children, junior high students, and a moms club. The students raised their audience’s awareness of microbes in and around us, of how to prevent contamination during food preparation, and of the significance of antibiotic resistance organisms and ways to prevent further resistance. They accomplished their goals through demonstrations, brochures, posters, and presentations.

Students were also required to develop an assessment tool that they then used to determine impact on the target audience. Assessment of students involved in the service learning took the form of reflections on the experience. The results demonstrate that in addition to enjoying the experience and the microbiology they learned, the students developed skills that will prove useful later in their careers.
49-A
Bridges to the Future- Increasing Minority Student Participation in the Biomedical Sciences


The under representation of minorities in biomedical research programs has long been identified as a significant factor affecting health disparities in the U.S. The NIH Bridges to the Baccalaureate Degree Program is a federally funded initiative to increase the representation of minorities in the biomedical sciences. This program has allowed Southwest Tennessee Community College –a large, urban community college- to serve as a substantial resource for identifying minority students with the potential to make the transition from the two-year college to a biomedical research career. The Southwest project identifies eligible students very early in their academic career, and places them in a mentoring program that provides advising, guidance and science skills instruction during the spring semester. This prepares the student for a summer research experience where they are placed in existing research laboratories at four-year institutions and participate in ongoing research. The project has presented a cohort of promising minority students to the nature of biomedical research and has proven to be a successful tool in encouraging under represented students to pursue higher degrees in the biomedical sciences. During a three-year period, the Southwest Tennessee Bridges to the Biomedical Sciences Program has successfully bridged participants to bachelors’ programs at four-year schools. Additionally, the long-term success of this program is being measured by tracking the academic careers of the students for as long as is practical.

50-B
A Successful Distance Learning Microbiology Course for High School Students

L. Rodriguez¹, C.A., Moreno¹ and V. Tucker²
¹The University of Texas Health Science Center at Houston and the ²Spring Branch Independent School District, Houston, TX.

To stimulate the interest of high school students in science, The University of Texas Health Science Center at Houston (UTHSC-H) provides a 9-week course in microbiology by interactive video. Topics include the history of microbiology, impact of disease in society, infectious diseases in the Texas-Mexico border region, Ebola virus research, identifying pathogenic microorganisms, malaria, trichinosis, and emerging infectious diseases. Instructors are faculty members from UTHSC-H and other UT System schools. Lessons are presented from a video studio on our campus that is dedicated to K-12 instruction. Video instruction is complemented by laboratory exercises, selected readings, quizzes, and computer-based assignments. Students take a video tour of the diagnostic microbiology laboratory at our affiliated teaching hospital. The laboratory director provides live narration and students can interview laboratory personnel. The course concludes with a presentation on career opportunities in the field of microbiology. Learning standards from the course follow the National Science Standards, and Texas Essential Knowledge and Skills (TEKS), established by the Texas Education Agency to guide science instruction in public schools. The course is successful as determined by an independent evaluation. [Initially funded by NIH Science Education Program Grant (5 R25 11466), Science Partnership Award (5 R25 RR15632), a special appropriation from the 75th Texas Legislature, the Texas Telecommunication Infrastructure Fund, and Time-Warner Communication].
51-C
Upper-level Undergraduates Teach Marine Microbiology to 5th Grade Students

*Elise R. Sullivan. University of New Hampshire, Durham, Durham, NH.

One major component in my writing-intensive, marine microbiology class is to visit a local elementary school and have upper-level college students teach 5th graders basic concepts about marine microbes. This assignment developed from wanting students to be able to discuss complex scientific concepts to non-scientific audiences. The overall project, which constituted 20% of the total grade, involved five major components: 1) a short critical review paper on a primary literature article of the same topic the undergraduates were to teach to the 5th graders, 2) small-group development of a teaching station that included a poster and hands-on demonstration, 3) a written description of the teaching station reviewed by the 5th grade teachers prior to our visit, 4) teaching the 5th graders on the day of the project, and 5) a short reflective essay on my student's experience as educators. Four teaching stations were developed on the following topics: physical/chemical properties of the local estuary, biofilms, photosynthetic organisms, and unusual marine microbes. On the day of the presentation the 5th grade students rotated in small groups around the stations where they participated in hands-on activities and discussed concepts. Overall, my student's attitude towards the experience was extremely positive and several said it was the best experience they had in college. Their reflective essays highlighted the challenges and creativity needed to communicate science to a non-technical audience. This class project demonstrates an effective means to bring science outside of the traditional classroom and, in the process, enhance the learning motivation of students.

52-A
Influence of >100 Years of Tannery Activity on a Wetland Community: A Service-learning Project for Undergraduate Microbiologists

*David S. Treves. Indiana University Southeast, New Albany, IN.

In this project a student-community partnership was established to conduct a hands-on microbiological investigation of the effects of >100 years of tannery activity on a wetland community. The study site includes a 47-acre wetland in close proximity to a tannery that was operational from the late 1800s to early 2002. Students enrolled in Microbial Ecology, an upper level course for undergraduates, examined a variety of unique environments including tanyard pools within the tannery complex, soils potentially contaminated by tannery waste, and water and sediment from two outdoor waste lagoons. Throughout the study, standard culture-dependent methods were compared to molecular-based culture-independent techniques such as ARDRA and PCR-DGGE. Student activities included, i) interfacing with the landowner to construct a hypothesis-driven research plan to investigate the wetland site, ii) completion of a suite of microbiological tests designed to address the proposed hypotheses, iii) composition of a final report that was presented to the landowner. Additionally students participated in a wetland cleanup and visited an elementary school science club to foster interest in microbiology.
53-B  
A Virtual Laboratory for Microbiology on CD  
G.J. Delisle and L.L. Tomalty. Queens University, Kingston, Ontario Canada.

This interactive laboratory uses full multimedia including graphics, digital images, video, animation and audio. Extensive user interactions are found at all levels of the laboratory.

The CD is bilingual (English/Spanish) with synchronous switching between the languages, i.e., all elements currently visible and audible (including interface and content) immediately appear in the chosen language.

The Virtual Laboratory consists of:

a) A CASE BASED MODULE with multiple scenarios incorporating clinical and environmental specimens that the student identifies to genus and species both by API testing, traditional tube tests or the appropriate DNA or protein probes.

b) A UNKNOWN ORGANISM MODULE where the educator alone has the key and can direct students to test for a variety of specific organisms.

These modules are supported by

a) A DIAGNOSTIC MODULE providing specifications and interpretations of laboratory tests,

b) A HEALTH AND SAFETY MODULE outlining proper handling procedures specified by WHO and CDC/NIH guidelines,

c) A GLOSSARY MODULE providing an audible pronunciation guide and definitions.

The authors will demonstrate the use of the virtual laboratory as a learning tool complementary to the "wet" laboratory particularly as it relates to issues of biohazard safety and the identification of organisms that cannot be used safely in the traditional student laboratory. The CD is in progress and the authors are interested in feedback from the undergraduate educators in order to tailor their needs to this project.

54-C  
Teaching Bacterial Pathogenesis Using Bioinformatics and Genomics Approaches  
*Janelle Hare. Morehead State University, Morehead, KY.

"Changing Concepts in Pathogenesis" is a 300-level elective I developed for biology undergraduates who have not taken microbiology. To make this course attractive and accessible, I structured it to have a conceptual, not organismal, focus on how scientists research and understand microbial pathogens with new molecular, genomic, and bioinformatic technologies. To support our classroom activities, we used computer lab projects. We examined how societal changes result in new pathogens, and how new technologies help us learn about pathogens. We first used the Bacterial Pathogenesis text to learn about microbes, host defenses and bacterial genetics. Later, we read the primary and secondary literature to understand recent advances such as in vivo technologies and microarrays. We used the Lasergene Navigator software suite from DNASTAR, which is free for educational use, runs on both PC and Macintosh platforms, and contains a variety of DNA and protein analysis programs. However, because many bioinformatics texts focus on eukaryotic DNA analyses, I designed computer lab exercises that focused on bacterial genetics problems. Students learned the Lasergene software, navigated publicly available bacterial genome databases, and designed and conducted research projects using the software. Their topics included homologies among Type IV secretion systems, genes involved in crossing the blood-brain barrier, superantigens, toxin homologs, and differences in quorum sensing systems of pathogens vs. non-pathogens. Post-semester assessments indicated that students enjoyed the novel, in silico approach to studying microbiology, and learned new skills that they could apply to future studies in biology or computing.
55-A
Applying the Web-based IMMEX Platform to Teaching the Lactose Operon

David F. Johnson¹, Joycelin Palacio-Cayetano² and Ron Stevens². ¹University of California, Irvine, CA and ²The IMMEX Project, UCLA School of Medicine.

I (DFJ) lead discussion sections in our sophomore biology major core curriculum. An important goal of these sections is to develop critical thinking and problem solving skills. To help teach regulation in our molecular biology course, we have developed a web-based IMMEX (Interactive Multi-Media Exercise) problem solving simulation based on the lactose operon. IMMEX simulations begin with a starting condition and end with a specific goal. These two are linked by embedded data. In our example, the starting condition is the student being given a strain of E. coli with a mutation in the lactose operon. The student gathers information until he reaches a conclusion and identifies the mutation. The student can access lab data such as indicator plates, enzyme assays or various blots. To stimulate metacognition (and discussion) after the assignment, students were asked to write a brief paragraph describing the most useful aspects of the problem.

As students perform an IMMEX simulation, the sequence of actions a student takes is recorded into a transaction log, called a search path map. The order in which decisions are made provides insights into the way a student organizes and applies knowledge. Artificial Neural Network and Hidden Markov Modeling were used to analyze the search path maps from 2200 student performances. A comprehensive examination of IMMEX generated maps reveals that students tend to use five primary strategy types. It also reveals a shift in strategy as the student becomes more familiar with the problem set.

56-B
Using On-line Games to Teach Microbiology

Leslie M. Miller and Vicky Estrera. Rice University, Houston, TX.

The Center for Technology in Teaching and Learning, with an expert panel of infectious disease specialists, created a series of online adventures that incorporate virtual experiments and interactive games. The underlying concept was to capitalize upon the Internet gaming phenomenon in appealing to students, while at the same time presenting substantive microbiology content. The web site (http://medmyst.rice.edu) is funded by the National Institutes of Health, National Center for Research Resource. And while its focus is on teaching middle school students about the biology, history, and prevention of infectious diseases, it offers examples of how multimedia games can be crafted to teach science at any level.

A recent study of the web site's learning impact demonstrated that it is possible for students to learn basic concepts related to microbiology through this gaming environment. For example, a bacteria sorting game teaches students to recognize bacteria shapes. The game Infect-O-Rama teaches the principles of vectors and the role they play in disease transmission, and the game Germ Blaster teaches about common preventatives and treatments of infectious diseases.

In addition, virtual experiments that would normally be too costly or time consuming to do in a lab can be recreated on-line. One example is the experiment that demonstrates Koch's postulates. Students come away with a deeper understanding of the importance of Koch and his role in the history of science. The web site is not designed to take the place of quality classroom instruction, however, it does provide an alternative method of teaching science.

Since the creation and field test of the web site, hands-on activities have been added to the MedMyst materials. The presentation will emphasize the complementary hands-on labs and indicate how these can be correlated with the concepts in the on-line games. Sample activities will be demonstrated.
57-C
Choice of Treatment for HIV Infected-Individuals: An Exercise for Microbiology Courses

Maria D. Suarez. Holy Family University, Philadelphia, PA.

An exercise aimed at active learning of concepts related to HIV structure and function, the relationship between HIV and AIDS, and current approaches to anti-retroviral drug development, was implemented in an introductory microbiology course. The majority of students in the course are nursing majors. The exercise consists of asking students to assume they have to make a personal choice regarding whether to pursue treatment for a presumptive HIV infection and which treatment regiment to follow. They were also asked to evaluate the following websites available to the general public for these choices: www.AIDS.org; www.projectinform.org; and www.thebody.com. Students had a basic introduction to general retroviral structure before beginning the exercise. They were asked to conduct their initial research at a computer laboratory with the guidance of the professor and to write a short paper responding to specific questions regarding their choices. Evaluation of the exercise by the students indicated an overwhelming positive response. Students specifically expressed surprise at the complexity of information that patients are asked to process in making treatment choices and the profound changes in lifestyle that some drug regiments entail. Most were able to discuss their choice of drug regiment in significant detail demonstrating an understanding of viral structure and rational drug design.

58-A
Learning Support Materials to Accompany the Video Series ‘Unseen Life on Earth’: Produced by Students for Students

Joanna Verran. Manchester Metropolitan University, Manchester, UK.

The 1999 video series ‘Unseen Life on Earth’ provides a useful resource addressing basic and applied principles of microbiology. However, it is always preferable to provide a more active learning experience to accompany viewing of videos. The aims of this work were: to use a second year student to evaluate the series, identify key learning clips/programmes, and produce learning support materials/worksheets for first years; and to develop an exercise on emerging disease using the last video of the series.

Videos identified by the student as key were: microbial universe, diversity, evolution and interactions. She developed question based worksheets for first year classes to complete whilst watching the video. The academic staff member leading the lecture conducted revision question and answer sessions at the end of each ‘lecture’. Separate question sheets sought the students’ views of the video quality and were collected. Good responses during the revision session and from collected sheets indicated a positive experience. Some questions were modified for use in MCQ exercises at the end of the course. Results are not yet available.

The Hantavirus case study described in the video ‘microbes and human disease’ formed an introduction to emerging infectious diseases (EIDs) in the medical microbiology course (final year). Some of the questions provided on sheets for completion whilst watching the video were repeated during seminars some weeks after the video. There was a loss in information retention over time. In preparation for the seminar, students each collated a list of examples of at least 5 emerging diseases, and provided information on the factors responsible for emergence. A long list of diseases, and common features emerged through class discussion. Preparatory notes were collected, marked, and contributed to summary handouts. MCQs were included in a test. Students performed better in these questions than in the MCQ overall.

In both first and final year courses, the use of worksheets and accompanying activities appeared to reinforce key points addressed in the selected videos.
### Presenting Author Index

<table>
<thead>
<tr>
<th>Name</th>
<th>Presentation Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Al-Dujaili, J.</td>
<td>41-B</td>
</tr>
<tr>
<td>Anderson, M.G.</td>
<td>1-A</td>
</tr>
<tr>
<td>Anderson, M.K.</td>
<td>47-B</td>
</tr>
<tr>
<td>Baker, J.C.</td>
<td>30-C</td>
</tr>
<tr>
<td>Baresi, L.</td>
<td>31-A</td>
</tr>
<tr>
<td>Baros, B.</td>
<td>32-B</td>
</tr>
<tr>
<td>Begley, G.S.</td>
<td>2-B</td>
</tr>
<tr>
<td>Benoit, R.</td>
<td>3-C</td>
</tr>
<tr>
<td>Blair, B.</td>
<td>42-C</td>
</tr>
<tr>
<td>Bratina, B.</td>
<td>33-C</td>
</tr>
<tr>
<td>Breakwell, D.P.</td>
<td>4-A</td>
</tr>
<tr>
<td>*Cardinale, J.A.</td>
<td>34-A</td>
</tr>
<tr>
<td>Clemans, D.</td>
<td>35-B</td>
</tr>
<tr>
<td>Dawson, M.M.</td>
<td>5-B</td>
</tr>
<tr>
<td>Delisle, G.J.</td>
<td>53-B</td>
</tr>
<tr>
<td>Duboise, S.M.</td>
<td>44-B</td>
</tr>
<tr>
<td>*Ebomoyi, J.I.</td>
<td>6-C</td>
</tr>
<tr>
<td>Elmendorf, H.</td>
<td>43-A</td>
</tr>
<tr>
<td>Erbeznik, M.</td>
<td>19-A</td>
</tr>
<tr>
<td>*Farone, M.B.</td>
<td>20-B</td>
</tr>
<tr>
<td>Furlong, M.A.</td>
<td>36-C</td>
</tr>
<tr>
<td>Gedney, C.</td>
<td>9-C</td>
</tr>
<tr>
<td>Goodner, B.</td>
<td>7-A</td>
</tr>
<tr>
<td>*Hare, J.</td>
<td>54-C</td>
</tr>
<tr>
<td>Hinze, E.M.</td>
<td>21-C</td>
</tr>
<tr>
<td>Johnson, D.F.</td>
<td>55-A</td>
</tr>
<tr>
<td>Krasner, R.I.</td>
<td>8-B</td>
</tr>
<tr>
<td>Kreider, G.L.</td>
<td>17-B</td>
</tr>
<tr>
<td>Lauffer, S.</td>
<td>45-C</td>
</tr>
<tr>
<td>*Lipson, S.M.</td>
<td>16-A</td>
</tr>
<tr>
<td>Lux, M.F</td>
<td>10-A</td>
</tr>
<tr>
<td>Mangan, K</td>
<td>18-C</td>
</tr>
<tr>
<td>Melin, T.</td>
<td>46-A</td>
</tr>
<tr>
<td>Miller, J.H.</td>
<td>40-A</td>
</tr>
<tr>
<td>Miller, L.M.</td>
<td>56-B</td>
</tr>
<tr>
<td>Nold, S.C.</td>
<td>11-B</td>
</tr>
<tr>
<td>O'Connell, S.P.</td>
<td>22-A</td>
</tr>
<tr>
<td>*Okeke, I.N.</td>
<td>12-C</td>
</tr>
<tr>
<td>Panec, M.</td>
<td>48-C</td>
</tr>
<tr>
<td>Phythyon, J.R.</td>
<td>23-B</td>
</tr>
<tr>
<td>Pillay, I.</td>
<td>49-A</td>
</tr>
<tr>
<td>Rodriguez, L.</td>
<td>50-B</td>
</tr>
<tr>
<td>Rott, M.</td>
<td>13-A</td>
</tr>
<tr>
<td>Salisbury, V.</td>
<td>24-C</td>
</tr>
<tr>
<td>Shields, P.</td>
<td>25-A</td>
</tr>
<tr>
<td>*Shors, T.</td>
<td>26-B</td>
</tr>
<tr>
<td>Smith, K.M.</td>
<td>14-B</td>
</tr>
<tr>
<td>St. John, R.T.</td>
<td>37-A</td>
</tr>
<tr>
<td>Suarez, M.D.</td>
<td>57-C</td>
</tr>
<tr>
<td>*Sullivan, E.R.</td>
<td>51-C</td>
</tr>
<tr>
<td>Summers, M.L.</td>
<td>27-C</td>
</tr>
<tr>
<td>*Sundari, S.K.</td>
<td>38-B</td>
</tr>
<tr>
<td>*Treves, D.S.</td>
<td>52-A</td>
</tr>
<tr>
<td>Verran, J.</td>
<td>58-A</td>
</tr>
<tr>
<td>West, B.</td>
<td>39-C</td>
</tr>
<tr>
<td>Wohl, D.L.</td>
<td>28-A</td>
</tr>
<tr>
<td>Worthington, P.</td>
<td>29-B</td>
</tr>
<tr>
<td>Zwolinski, M.D.</td>
<td>15-C</td>
</tr>
</tbody>
</table>

**Presentation times:**

- **#-A** – 7:00-7:45pm
- **#-B** – 7:45-8:30pm
- **#-C** – 8:30-9:15pm

*Travel Grant Recipient*