POSTER SESSION INFORMATION & ABSTRACTS

May 18, 2002
7 – 9 P.M.
Ft. Douglas Officer’s Club

9th Undergraduate Microbiology Education Conference

University of Utah
Salt Lake City, Utah
Poster Session
Saturday, May 18, 2002
7:00 to 9:00 p.m.
Ft. Douglas Officer’s Club

All posters will be available for viewing in the Ft. Douglas Officer’s Club from 7:00 to 9:00 p.m. on Saturday, May 18, 2002. Abstract numbers represent session-location.

Session 1: Authors will be at their posters from 7:00 - 8:00 p.m.

1-1 The Power of Visualization in Teaching Genomics and Bioinformatics: Mutations in HIV Envelope Proteins and Their Consequences for Vaccine Design
Kathy Takayama*
The University of New South Wales, Sydney, AUSTRALIA

1-2 Outbreak: Applying Epidemiological Content Using Problem-Based Learning
Jeff Pommerville*
Maricopa Community Colleges, Tempe, AZ

1-3 Incorporating the Use of Small Groups of Students into Evaluation Strategies for a Clinical Microbiology Course
Mary F. Lux*
University of Southern Mississippi, Hattiesburg, MS

1-4 An Interdisciplinary Approach to the Microbiology Curriculum
Suzanne Kelly*
Scottsdale Community College, Scottsdale, AZ

1-5 Diversity in Teaching Methods for Medical Microbiology and Immunology Undergraduate Education
Beverly J. Barham*
Illinois State University, Normal, IL

1-6 Lab Projects in a Microbiology Course for Majors
Jacqueline Piret* and Kostia Bergman
Northeastern University, Boston, MA

1-7 Electronic Multimedia Guide for the Microbiology Laboratory
Alice D. Wright*, Ethelynda Harding, Candace Lee Egan, and David L. Frank
California State University Fresno, Fresno, CA

1-8 And the Band Played On: Lessons in Epidemiology
Janet L. Cooper*
Rockhurst University, Kansas City, MO

1-9 Improving Group-based Active Learning Activities in the Microbiology Classroom
Thomas M. Terry*, Michelle Rosado, Preston Garcia, and Brendan Keenan
University of Connecticut, Storrs, CT

* Submitting Author
● Travel Grant Recipient
1-10 **Antibiotic Resistance in *Streptococci* sp. Isolated from the Students of a Midwestern University**  
Burton J. Webb* and Cynthia Fletcher  
Indiana Wesleyan University, Marion, IN

1-11 **Promoting the Acquisition of Skills of Data Analysis in an Undergraduate Cell Biology Course**  
William S Bradshaw*, John D Bell, and Richard R Sudweeks  
Brigham Young University, Provo, UT

1-12 **Teaching Introductory Biology at Grinnell College using Microbiology and Inquiry-Based Methods**  
Janelle Hare*, Bruce Voyles, David Lopatto, and Leslie Gregg-Jolly  
Grinnell College, Grinnell, IA

1-13 **RAPD PCR In The Microbiology Lab: A Molecular Approach to Identification of Bacterial Unknowns**  
Jason C. Baker*, Todd T. Eckdahl, Richard E. Crumley  
Missouri Western State College, St. Joseph, MO

**Session 2: Authors will be at their posters from 8:00 - 9:00 p.m.**

2-1 **Fostering Active Learning Using the Primary Literature**  
Donald P. Breakwell*  
Brigham Young University, Provo, UT

2-2 **A New Twist on a Historical Pathogen: An Unusual Leprosy Case Study**  
M.A Lowder** and M.F Hite  
University of North Carolina at Charlotte, Charlotte, NC

2-3 **Using the Fish Pathogen *Renibacterium salmoninarum* as a Model System for Teaching Laboratory Techniques in Molecular Microbiology**  
James G. Daly*  
Purchase College, State University of New York, Purchase, NY

2-4 **Designing a Research-Based Course Using Genome Consortium for Active Teaching (GCAT) Resources**  
Alix G. Darden*  
The Citadel, Charleston, SC

2-5 **Training Freshmen To Think Like Microbial Scientists**  
Frank Caccavo, Jr.*  
Whitworth College, Spokane, WA

2-6 **Study Habits of University Students in a Large Lecture Class**  
Penelope J. Padgett*  
University of North Carolina at Chapel Hill, Chapel Hill, NC

* Submitting Author  
• Travel Grant Recipient
2-7  Teaching Undergraduates Grantsmanship: Student Peer Review of Grant Proposals
Benjie G. Blair* and George R. Cline
Jacksonville State University, Jacksonville, MS

2-8  Outbreaks: Real World Cases which Integrate Medical and Environmental Microbiology Core Concepts
Rodney P. Anderson*
Ohio Northern University, Ada, OH

2-9  Infusion of Biotechnology in the Maryland High School Biology Curriculum: Development of a Loaner Lab Program
Karen J. Dalton* and Thomas Burkett
Community College of Baltimore County, Catonsville, MD

2-10 Microbiology Course for Medical Students: Active Learning Through A Problem Based Learning Model
C.L. González* and María A. Mondaca
Universidad de Concepción, Concepción, CHILE.

2-11 Challenges to Learning Microbiology in English as Your Second Language
Liping Zhao*
Shanghai Jiao Tong University, Shanghai, CHINA

2-12 Learning and Teaching Biology: A Beginning Level Service Learning Based Course
Lee A. Abrahamsen*
Bates College, Lewiston, ME

2-13 Bringing Case Studies to Life in the Introductory Microbiology Laboratory
Ruth A. Gyure**
Western Connecticut State University, Danbury, CT

2-14 Web-based Introduction to Microbial Phylogeny
Beverly J. Brown*1, S. Fran2, L.T. Isaacs3, M.-K. Liao4*
1Nazareth College of Rochester, Rochester, 2NY Bradley Univeristy, Peoria, IL, 3Goucher College, Towson, MD, and 4Furman University, Greensville, SC
The Power of Visualization in Teaching Genomics and Bioinformatics: Mutations in HIV Envelope Proteins and Their Consequences for Vaccine Design

Kathy Takayama*
The University of New South Wales, Sydney, AUSTRALIA

The completion of the human genome sequence was met with worldwide acclaim throughout the scientific community as well as across the front pages of every major newspaper. Yet, exactly how one utilizes genomic sequence information is beyond the comprehension not only of the average citizen but also of many undergraduate students. How do educators convey the value of a genome sequence?

This project addresses the need to provide a visual context for teaching the practical applications of genome sequencing and bioinformatics. Present-day research relies on indirect visualization techniques (e.g., fluorescence-labelling of DNA in sequencing reactions) and a reliance on sophisticated computer analysis. Such methods are impractical and prohibitively expensive for laboratory classes. More importantly, there is a need for curriculum resources that visually demonstrate the application of genome sequence information rather than the DNA sequencing methodology itself.

This project is a collaborative tutorial and lesson plan that enables students to apply information contained within a genome sequence in a practical context. Its versatility makes it adaptable to most courses in the biological sciences. The specific example focuses on approaches to HIV vaccine design based on HIV genome sequences, using open-source freeware. Students perform comparative alignments of various HIV sequences available from a public database. Students then examine the consequences of HIV mutations by creating three-dimensional images of the HIV env protein structure, thus seeing the implications of vaccine design. The tutorial enhances problem solving through the application of one type of information (DNA/protein sequence) into concrete visual conceptualizations.
A challenge faced by many instructors is engaging and motivating students. One strategy to meet this challenge is to present students with problem-solving activities that use real-world examples. We have designed and field-tested a problem-based learning (PBL) exercise whereby allied-health and nursing students apply their knowledge of epidemiology to a real-world situation. In this PBL module, cooperative groups (disease detectives) are given an ill-defined problem - a health department report describing increased cases of Legionnaires’ disease. If the groups decide that an outbreak actually exists, they must analyze the problem and determine what information they already know, decide what additional information they need to acquire, and produce an action plan to obtain the needed information. Student groups work outside class to discover the source of the outbreak and engage in activities that include generating an epidemiological curve and calculating odds ratios. The instructor is facilitator, guide, and resource specialist, assisting groups without directing them. Each group produces a final written report describing all aspects of their epidemiological investigation and completes self-, group-, and instructor-performance evaluations. Based on the report, evaluations, and student surveys, we found that the PBL exercise engaged students in group discussions and encouraged different approaches to problem solving. Students described the exercise as interesting and appropriate, indicating that they saw the connections between knowledge learned and its application in the real world. In addition, we concluded that this exercise promoted the critical thinking, communication, and social skills that science and the community require.
The use of group activities can be a valuable strategy to promote active learning in the classroom. Small group activities, such as brief in-class group discussions or writing assignments may stimulate students' interest and enhance learning. Emphasis on small group work prepares students for the reality of the workplace. Few work environments promote the "Lone Ranger" approach, most encourage and reward the use of teamwork and collegiality. The natural progression of small group activities during lecture time is to include group evaluation strategies. I have students work in groups for a number of quizzes throughout the course. I also have incorporated a test component in which students respond to selected items as a group. This group testing strategy is used in three of the four major tests in the course. The group test component consists of two or three case histories on each of three tests. As one might predict, the performance of the group surpassed the performance of individual students. The group interaction allowed students to discuss and reinforce various responses within their group and the student response to this test component was enthusiastic. However, the average test grades and course grades, were not markedly higher than scores from previous classes in which students worked as individuals.
An Interdisciplinary Approach to the Microbiology Curriculum

Suzanne Kelly*
Scottsdale Community College, Scottsdale, AZ

The need to revise traditional science curriculum and pedagogy has been promoted by both government and nongovernmental education agencies. These changes include a curriculum that incorporates cooperative learning, inquiry-based methods, problem solving, and hopefully, an interdisciplinary approach. We have designed, developed, and field-tested an interdisciplinary module to teach genetics, DNA, and mutations in the undergraduate microbiology course. In the classroom, students develop core concepts from physics on the generation and properties of the electromagnetic spectrum. Additionally, they actively discover and apply the Inverse Square Law, which expresses the relationship between radiation intensity and distance from a radiation source. They further explore the role of radiation as a cause of mutations and cancer development in living organisms, which provides an opportunity to introduce the chemical mechanism of ozone and the action of sunscreens. Microbiology students then use these concepts in an applied situation. In a hands-on, problem-solving laboratory period, they test hypotheses about the role of the Inverse Square Law and UV light in causing mutations. Students work cooperatively to design experiments to investigate whether (1) UV radiation can cause mutations that prevent pigment formation or even kill *Rhodotorula rubra* yeast cells and (2) if *R. rubra* can be used as a test organism to demonstrate the effect of protective sunscreen agents. Student experimental results are evaluated through a poster presentation. Assessment of the module includes both pre- and post-tests and student attitude surveys. An interdisciplinary approach to microbiology affords students an integrated, interesting and useful way to apply course knowledge.
Diversity in Teaching Methods for Medical Microbiology and Immunology Undergraduate Education

Beverly J. Barham*
Illinois State University, Normal, IL

Through implementation of a variety of classroom assessment techniques and the use of manipulatives, the learning potential for undergraduate medical microbiology and immunology students can be maximized. Identifying what students are learning and how well they are learning it through a variety of formative and summative classroom assessment techniques allows the instructor to identify problem areas long before the first test question is ever written. Classroom assessment techniques including the muddiest point, one minute papers, good faith efforts, and concept mapping have been used successfully in the medical microbiology and immunology undergraduate classroom. Additionally, enhanced student engagement can be achieved through the use of manipulatives as a "hands on experience." This allows students to learn such things as the essentials of different laboratory testing methodologies including fluorescent antibody testing, enzyme linked immunosorbent assays, and a variety of molecular diagnostics. The use of manipulatives also allows for theory of the newest technologies to be taught without tapping already limited resource dollars. Students can be challenged to design new testing strategies to solve a particular problem in groups or individually. Recognizing that students have diverse learning styles and implementing different strategies to complement that diversity, assures that the next generation of microbiologists and immunologists will have a strong foundation in each discipline.

* Submitting Author
• Travel Grant Recipient
About six years ago we decided to create a new first course in microbiology for the start of the sophomore year. The primary goal was to excite students about the diversity of the unseen world of microorganisms early in their careers. Our method was to let them in on the hard work, frustrations, and eventual joys of real experimental work. To break the habits of years of viewing science as something learned from the teacher or the book, we decided early on to include a project as part of the laboratory work.

We find that each time we teach the course, the project becomes a larger part of the laboratory. We currently devote at least half of the ten-week quarter to the project. The work has varied with instructor but usually includes: two periods of in-class brainstorming; an initial proposal draft by each team of two to four students; feedback on this proposal draft from the TA and the instructor; at least one more draft of the proposal; oral presentation of the proposal to the class; four to five lab sessions of experimental work including repeats if appropriate; data analysis and preparation of oral presentations by each team; and a final written report by each student.

We will show and discuss examples of student projects including proposals and final reports. We will emphasize the growth that occurs as students participate in the iterative process of proposal preparation.
Electronic Multimedia Guide for the Microbiology Laboratory

Alice D. Wright*, Ethelynda Harding, Candace Lee Egan, and David L. Frank
California State University Fresno, Fresno, CA

Research suggests that investigative laboratories are more effective in teaching science process skills and in achieving higher order learning than traditional cookbook laboratories. However, perhaps due to the centrality of laboratory skill acquisition, many microbiology laboratory manuals follow traditional cookbook formulas. We are developing a multimedia electronic laboratory guide that will give students first exposure to new laboratory techniques outside of class. The guide is not a laboratory manual, but an integrated, hyper-linked presentation of essential methods and equipment used in microbiology laboratories. We will present "first drafts" of modules covering laboratory safety, aseptic techniques, enumerating microorganisms, and spectrophotometry. We will also present the results of an initial evaluation of the effects of exposure to the module on student ability to learn the streak plate technique. In this study, students in three of six laboratory sections viewed the module one week prior to streaking plates for the first time. Self-reported student comfort with the technique, the nature of questions students asked of instructors during laboratory, and the quality of resulting streak plate results showed little difference between the control and experimental groups. In future trials, we plan to encourage students to view the electronic laboratory guide outside of class, and more immediately prior to their first attempt at a new technique. We hope that this application of instructional technology will increase students' confidence in their laboratory skills and their willingness to work independently. We will be seeking additional sites for the evaluation of the laboratory eguide.
And the Band Played On: Lessons in Epidemiology

Janet L. Cooper*
Rockhurst University, Kansas City, MO

The video, “And The Band Played On” (HBO) is a useful tool in a discussion on epidemiology to demonstrate the 10 steps in an outbreak investigation as described by the Global Health Odyssey website: http://www.cdc.gov/excite/outbreak.htm. These steps include: 1) prepare for field work, 2) establish the existence of an outbreak, 3) verify the diagnosis, 4) define and identify the cases, 5) describe and orient the data, 6) develop the hypothesis, 7) evaluate the hypothesis, 8) refine the hypothesis, 9) implement control and prevention measures and 10) communicate the findings. Evaluation of student learning from the exercise has been assessed through use of a study guide designed not only to discuss the steps but also to stimulate student interest in AIDS. These studies in epidemiology help to improve a student's research and critical thinking skills using a problem oriented approach.

The video is also instructive in the role of disease in society and public policy formulation. Students construct a timeline from the video of both scientific and social events described by the movie. Follow-up to the events in the movie can be provided for the students which usually deal with the accuracy of the movie and the current status of the individuals in the movie.

Finally, ethical dilemmas presented in the movie are also discussed. The top three issues identified by the students from the video include funding for diseases, the issues of testing blood (cost versus benefit analysis) and scientific integrity.
Improving Group-based Active Learning Activities in the Microbiology Classroom

Thomas M. Terry*, Michelle Rosado, Preston Garcia, and Brendan Keenan
University of Connecticut, Storrs, CT

Implementing effective group activities into a predominantly lecture-based class is challenging. Whether such attempts succeed depends on several factors, especially: 1) choosing activities that are relevant and challenging, yet suitably short;  2) structuring groups to develop some cohesion; 3) finding an appropriate grading rubric to balance group and individual efforts; 4) providing feedback so questions raised by the activities are answered promptly; and 5) assessing and improving the process.

Several years of experimentation have helped to discover some pitfalls and some successful strategies. We currently use "worksheet activities" that are written with graduate student and faculty collaboration and handed out with unpredictable frequency, on average every other class period. These take about 15 minutes to complete, and always include questions "outside the box" that require students to work with their group to apply recently learned ideas in a new context. Activities are graded by a simple grading rubric - most students receive full credit for participation, but no credit if absent. Completion of at least ten such activities (out of 12) will result in 10 points towards the 100 total course points. Once the activity is completed, an online answer key is made available which can be used during class to answer the most challenging questions. Group cohesion is increased by including a group portion of all exams; immediately after completing the exam individually, students regroup, retake the same exam as one group, and all receive bonus points if the group outscores the highest individual grade. Sample materials will be available.
Antibiotic Resistance in *Streptococci* sp. Isolated from the Students of a Midwestern University

Burton J. Webb* and Cynthia Fletcher  
Indiana Wesleyan University, Marion, IN

Engaging undergraduate students in research improves both their learning and the likelihood that they will pursue careers in science following graduation. To that end we have designed an ongoing educational research project that catalogues the development of antibiotic resistance in the student population of a small liberal arts university. Antibacterial resistance is a widespread problem from which college communities are not exempt. Indeed, colleges and universities throughout the country may represent an ideal location for diverse populations of bacteria to share the genes required for antibiotic resistance. To determine the prevalence of antibiotic resistant *Streptococci* sp. in the student population of a midwestern university, samples were collected (via throat swab) from patients complaining of upper respiratory distress at the university sponsored health center. These samples were subsequently cultured on appropriate growth media, those identified as members of the *Streptococcus* sp. were subcultured and tested for resistance to a wide variety of antibiotics. As expected few bacterial isolates were resistant to the antibiotics Rifampin, Cephalothin, and Cefazolin. However, Tetracycline, Erythromycin, and Ciprofloxin resistance was higher than expected. In the resident university population, factors that foster the spread of antibiotic resistance genes in the student population may include: crowding of students from diverse geographic locations, failure to seek appropriate medical assistance, non-compliance with prescribed antibiotic regimens, and travel associated with breaks in education. In this study, we have analyzed the prevalence of antibiotic resistance and have begun the process of discerning factors associated with its spread that are especially prevalent at the university.
Promoting the Acquisition of Skills of Data Analysis in an Undergraduate Cell Biology Course

William S Bradshaw*, John D Bell, and Richard R Sudweeks
Brigham Young University, Provo, UT

It may often be assumed, incorrectly we believe, that students will naturally acquire the habit of scientific thinking in the course of readings biology texts or listening to traditional lecture presentations. We have assessed student performance on problems requiring the ability to interpret data from the experiments of cell biology across courses with quite different didactic strategies, and demonstrated that, in the absence of specific assistance and practice, achievement is significantly reduced. The challenge then is to devise learning activities, both in and out of the classroom, that will promote these intellectual skills. We will cite examples from our experience that 1) require students to engage in active communication, 2) demonstrate the utility of visualizing abstractions (such as experimental protocols students have not actually attempted), and 3) permit students to engage in self-assessment of their analytical and communication skills. The results of the use of computer-assisted simulations of cellular and molecular research techniques will be presented. We will also describe our experiments with novel course organization schemes designed to tailor pedagogy to specific student needs. A teacher who chooses to utilize any of these strategies must, of necessity, reduce the breadth and depth of subject matter coverage.
Teaching Introductory Biology at Grinnell College using Microbiology and Inquiry-Based Methods

Janelle Hare*, Bruce Voyles, David Lopatto, and Leslie Gregg-Jolly
Grinnell College, Grinnell, IA

The Grinnell College Biology department has developed a new curriculum based on a suite of introductory biology courses entitled "Introduction to Biological Inquiry." These courses each have a different specific topic, but are united by their common goal of learning science as a process that biologists do, rather than a collection of facts to be memorized. Our "workshop" format combines discussion, lecture, and laboratory time and uses both the primary literature and “Investigations” (a handbook written by the Biology and Chemistry faculty) to guide students in performing and communicating research. Students conduct novel, authentic research on their chosen course-related topic and report their results in both a scientific paper and a poster session for the college community. We chose to use bacterial model systems to explore the basic biological concept of organisms' responses and adaptations to their environment in two courses, "Emerging Pathogens" and "Biological Responses to Stress." Students employ microbiological techniques such as single colony isolation and growth monitoring, as well as the molecular biological techniques of cloning and PCR to test the roles of genes involved in antibiotic resistance or adaptation to environmental stresses. Other student projects have used mutant bacterial strains to highlight the interplay between genotype, phenotype and environment that occurs in both pathogens and non-pathogens. Pre- and post-semester assessments indicated that students significantly improved in their ability to design experiments, interpret data, and describe the role of genes in determining an organism's phenotype, and that a student's learning style modulates the degree of their improvement.
1-13  RAPD PCR In The Microbiology Lab: A Molecular Approach to Identification of Bacterial Unknowns

Jason C. Baker*, Todd T. Eckdahl, Richard E. Crumley
Missouri Western State College, St. Joseph, MO

Standard microbiology lab manuals provide few activities using modern molecular biology techniques to investigate microorganisms. We developed and implemented the use of Random Amplified Polymorphic DNA RADD PCR in the microbiology student lab as a molecular method for identification of bacterial unknowns. Over the course of three lab periods students worked in groups to perform RAPD PCR on a variety of known and unknown gram-positive and gram-negative bacteria. Students learned to set up and perform PCR as well as agarose electrophoresis. More importantly, students spent time analyzing and evaluating experimental data, interpreting electrophoresis band patterns, and identifying unknown bacteria. The two RAPD primers chosen provided good quality band patterns. The distribution of known and unknown species forced students to share data and compare band patterns across gels in order to identify unknowns. This method provided students the opportunity to perform modern molecular techniques in a microbiology lab and allowed opportunity to evaluate and interpret experimental results. From this activity, undergraduate students learn the value and application of techniques traditionally performed in genetics courses. We feel this activity is a valuable application of a modern molecular technique and could easily be integrated into any microbiology course to complement traditional bacterial identification methods.
A strategy was developed for using the primary literature to foster active learning in an allied health microbiology course. Recent journal articles that underscored the fundamental microbiological principles to be learned in each course unit were selected. At the beginning of the semester, students were taught the relationship between the layout of scientific articles and the scientific method. During the rest of the semester, students were oriented to the topic of each paper by a variety of methods: videos from “Unseen Life on Earth” were viewed, assignments from the text were read, a study guide was completed before class, and then students participated in mini-lectures and discussions. After all preparatory material was covered, a paper was read and discussed in groups and as a class. Students were assessed using daily reading quizzes, end-of-unit conceptual quizzes, and the ability to write an abstract based on a few papers that they had chosen and read. A self-assessment technique measured student cognition of the terms used in each unit’s scientific article with pre-read and post-read word lists. Approximately 90% of students agreed that reading the scientific articles was a valuable part of the class and that it provided context for their study of microbiology. For the self-assessment, the percentage change between pre-read and post-read word cognition was, as expected, highly significant. Conceptual quiz grades averaged approximately 75%. This study showed that introducing the scientific literature to allied health microbiology students can be an effective way of teaching microbiology by providing context in light of current literature and the scientific method.
An assignment was designed for students in an upper-level Pathogenic Bacteriology laboratory. During the semester, students isolate non-pathogenic organisms from their normal flora. A major drawback to this approach is that students are unable to work with the actual pathogens being studied. Although they are isolating harmless flora, we focus on pathogenic species within each isolated genus. This allows us to provide medical relevance to the lab and elaborate on clinical characteristics and features of many pathogens and diseases. The challenge lies in expounding the importance of these pathogens and introducing certain organisms not isolated from their normal flora, such as the genus *Mycobacterium*. Therefore, a case study was developed using a current patient report from a medical Internet resource (Medscape's MedPulse, www.medscape.com/viewarticle/410028). This on-line report details a recent case of *Mycobacterium leprae* from the New Orleans area including: patient description, differential diagnosis, hospital course, and treatment. Interestingly, it also introduces the historical implications of leprosy and raises questions regarding transmission and reservoirs for this pathogen. We have used this resource to design a written assignment for our students; it has been implemented and successful over two semesters. Students are asked to: 1) define medical terms, 2) examine variability in the patient's symptoms, 3) review the course of treatment, 4) create an informative pamphlet for public health use, and 5) write a discussion of the historical significance/socioeconomic impacts of this pathogen. All aspects of this assignment will be detailed, example reports from students will be displayed, and an overall evaluation method with grading rubrics will be provided.
Renibacterium salmoninarum is a gram positive facultative intracellular pathogen of salmonid fishes. Since it is psychrophilic, it is not pathogenic to humans while remaining pathogenic to salmon and trout. This fastidious bacterium is slow growing, taking greater than 10 days to give visible growth on specialized media and thus is an excellent example of why we use molecular methods (ELISA, PCR, Western Blot) for quick detection of the bacterium. This bacterium has been used as a model system for four years to teach molecular bacteriology techniques to undergraduate students in a general microbiology laboratory. Students taking the course are biology students in an undergraduate liberal arts setting. Through a series of four laboratory sessions, junior and senior students learn a number of important methods (culture of a fastidious bacterium, indirect fluorescent antibody technique [IFAT], ELISA, PCR, and Western Blot) to detect this slow growing bacterium. Experience has shown that the students have difficulty with their first gels but by the second session they generally are run well. Lab sessions are 3 hours long and involve students coming into the lab after the general lab session. These labs have been well received by the students. They have stated that actually doing these techniques is far more beneficial than reading and hearing about them in lecture. The difficulty with this approach is that some other traditional labs must be removed from the 14 week lab curriculum.
A molecular genetics course was designed to have students learn how research is done by having them research, design, and implement a novel research project. Students were told that the project would involve investigating yeast stress responses using yeast microarrays. Yeast microarrays, access to a chip reader, protocols and a listserve was provided through the Genome Consortium for Active Teaching (GCAT) which has funding from NSF. A class of four students was instructed to research the literature on yeast stress responses and pick a stress condition that would use for their experiment. The students were provided with generic protocols, which they customized to their experimental conditions and laboratory environment. They then grew yeast under stress and nonusers conditions, isolated RNA, and made cDNA fluorescent labeled probes, which were hybridized to the yeast microarrays. Once the microarrays were scanned, the data were analyzed and interpreted. Assessment of student performance included presentation of a journal article to the class, synopses of all journal articles read during the semester, annotated laboratory protocol for the entire experiment, a journal style research paper, and presentation of the project to lower level biology classes. Student responses to the course were very favorable. The instructor, who has experience in basic molecular biology techniques, has never used microarrays or worked with yeast. The protocols and listserve associated with GCAT were very informative and made this teaching adventure a positive experience.
2-5  Training Freshmen To Think Like Microbial Scientists

Frank Caccavo, Jr.*
Whitworth College, Spokane, WA

A seven week introductory course was designed to teach freshmen college students the skills required to do science within the context of microbiology. The core themes of microbiology were presented through a combination of lecture and segments from the video series "Unseen Life on Earth: An Introduction to Microbiology." For example, a video segment describing the processes within a wastewater treatment plant reinforced the concept of respiration. Video segments were thereby used to provide real-world context for the concepts presented through lecture. Microbial diversity was taught through internet-based student presentations. This activity encouraged students to take ownership of some of the material presented in the course and allowed them to develop oral communication skills. The student audience graded each presentation using an evaluation form, thus developing critical analysis capabilities. In lieu of exams, students were assessed on course content through weekly group problem solving. Students were taught basic microbiology laboratory skills during the first two weeks of the course. They then formed research teams and developed and performed their own independent, laboratory, research projects. This exercise taught students how to ask scientific questions, develop hypotheses, implement experimental methods, analyze data and collaborate. Laboratory activities culminated in a mini-symposium in which each team presented a poster describing their research project. Students rated each aspect of the course on a numerical scale after four weeks. The mean scores from these evaluations suggested that the methods facilitated student learning, interest in microbiology, and comprehension of requisite scientific skills.
Study Habits of University Students in a Large Lecture Class

Penelope J. Padgett*
University of North Carolina at Chapel Hill, Chapel Hill, NC

Biology 11, Principles of Biology, is the introductory biology course that all freshmen at the University of North Carolina at Chapel Hill (UNC-CH) must take. It is a prerequisite for all upper level biology courses, including Microbiology. Students in this class, particularly the Biology majors, frequently ask the instructors to help them develop study skills that will enable them to better prepare for upper level courses. Many report that the methods that they used to study in high school are inadequate to be successful in college.

Students enrolled in Biology 11 at UNC-CH during the Spring semester 2002 were asked to evaluate their study habits after their second (of four) exams in the course. The students had received their scores from both tests at the time the questionnaire was administered. A one page questionnaire consisting of six questions concerning study habits and a short demographic section was distributed to the class at the end of a class period. No identifying information was collected from the students and students were not required to complete the questionnaire. Questionnaires were collected by the supplemental instructor and turned into the investigator. There were 271 students enrolled in the class, 235 turned in the questionnaire and of these, 168 were completed and were used in the analysis. Seventy percent of the students were female and 85% were freshmen. The majority of the students reported that they spent more than six hours studying for the exams and 80% stated that this was increase in the time spent studying for tests in high school. The most common study methods used to prepare for the first test were reading and outlining the assigned chapters, answering the questions in the back of the chapters, and making review questions and flash cards. Most students indicated that they changed some of their methods of studying after the first two tests if they felt their methods were not resulting in success. The major reason given for changing study methods was the feeling that the students needed to develop more effective study habits than they had in high school.

Results from this questionnaire have been shared with the class and feedback has been requested. The investigator plans to continue to collect data from subsequent Biology 11 classes and share this information in order to help students develop effective study habits.
Teaching Undergraduates Grantsmanship: Student Peer Review of Grant Proposals

Benjie G. Blair and George R. Cline
Jacksonville State University, Jacksonville, MS

Developing the ability to critically assess scientific research is an important part of becoming a scientist, yet there is little formal training to help students develop the appropriate skills. For ten years our department has emphasized undergraduate research and has attempted to incorporate it into our curriculum. As part of our sophomore level Introduction to Research class, we have required that students submit a written research proposal that is evaluated by the instructor. This year we extended this project by having students submit their proposals to an 'external funding agency' (students in the other section of the course). Students in each class were organized into two "NSF style" grant review committees and asked to evaluate the proposals based on scientific quality, budget, format, and overall proposal quality. Students reported detailed criticisms of the scientific methodology and the proposed budgets. They also ranked the proposals and awarded funds from a limited funding source. Participation in this project tested cognitive, analytical, and communication skills. Interpersonal skills became important in the ‘funding’ portion of the project. Student response was remarkable. From the first day of reviewing, student comments were insightful, constructive, and reasonable. Additionally, through critically editing these proposals, they came to recognize, and correct, errors in their own proposals.
Outbreaks: Real World Cases which Integrate Medical and Environmental Microbiology Core Concepts

Rodney P. Anderson*
Ohio Northern University, Ada, OH

Introductory microbiology courses often compartmentalize information to present basic concepts in a sequential, more easily understandable manner. However, professions that require microbiology education require the synthesis and integration of a broad base of knowledge. One of the more difficult tasks for instructors is to provide real-world learning opportunities that require integration of knowledge from diverse areas. Traditional case-based approaches used in Introductory Microbiology often focus on the medical aspects of single-patient cases. The purpose of this project was to develop a series of cases that 1) required integration of core concepts of microbiology across several themes; 2) covered all the systems and modes of transmission typically covered in medical microbiology; and 3) used material from real-world outbreaks. Here the development of about 50 case studies based primarily on recent outbreaks reported in news accounts and outbreak reports from the World Health Organization and the Centers for Disease Control and Prevention are outlined. Analysis of the outbreaks requires students to synthesize and integrate core concepts from basic, medical and environmental microbiology. These outbreaks have been used in a limited case-based teaching strategy that has used both cooperative-learning-based and individual student approaches. Student performance in analysis of the cases over the past 5 years has been significantly better when a team approach to case analysis was utilized.
To promote biotechnology education within the state of Maryland, The Community College of Baltimore County, with assistance from the National Science Foundation, has organized a loaner laboratory program to support teacher developed laboratory exercises for the high school classroom. The program also supplies trained teachers the supplies and equipment necessary to conduct the laboratory exercises.

Laboratory exercises were co-developed by high school science teachers and community college faculty that emphasize skills and knowledge from the Maryland State Core Learning Goals. The developed exercises have multiple components that can be used independently or as part of an ongoing story. Currently the laboratory exercise modules focus on marine biotechnology and food biotechnology. The modules contain laboratory experiments (DNA extractions, gel electrophoresis, transformation, PCR) and writing and discussion exercises that can be used in a typical high school class to foster an understanding of the science and implications of biotechnology. Any equipment and supplies that are needed for the activities are supplied at no cost to interested Maryland teachers.

We have collaborated in the development of mobile labs that will provide biotechnology training to Maryland's rural counties. With an increase in teacher training, we hope to infuse biotechnology into all counties in Maryland, not just the few where biotechnology is a leading industry.
Microbiology Course for Medical Students: Active Learning Through A Problem Based Learning Model

C.L. González* and María A. Mondaca
Universidad de Concepción, Concepción, CHILE.

We improved the teaching-learning process for medical students by moving from passive learning to a more active course. The aim of the project was to evaluate the impact on the knowledge acquired by medical students when they are responsible of their learning process. The course was modified by decreasing traditional lectures, including clinicians giving conferences, and by using clinical problems to be analyzed and presented by the students. The students were grouped in small number (less than five) with free access to literature. At the end of the course, the students were asked about their degree of satisfaction, the amount of knowledge acquired, the new role of the teachers, and if they felt more comfortable with this type of learning. The results indicate that among 69 students, more than 90% felt more confident with the new strategy, learned the themes in more depth, and desired to repeat this type of course. Eighty percent also preferred team learning to traditional lectures. In summary, the results suggest that this strategy of teaching is more stimulating for the students and allows teachers greater contact with them.
2-11 Challenges to Learning Microbiology in English as Your Second Language

Liping Zhao*
Shanghai Jiao Tong University, Shanghai, CHINA

To improve education quality in higher institutions in China, it is required that in the curricula for undergraduate students in natural sciences, at least two - three subjects for each major be taught in English. As an experiment, introductory microbiology for the majors of biology, biotechnology and environmental engineering was given in English in the first semester of the 2001-2002 school year in the College of Life Science and Biotechnology, Shanghai Jiao Tong University, to 120 third year students for 64 lecture hours. In order to evaluate teaching and learning progress, all students were required to write 10 questions. More than 1000 different questions were collected and analyzed. Seventy percent of the questions resulted from poor understanding of the English teaching contents. Two obstacles existed for proper learning of microbiology in English as a second language. The first was the "word for word" reading habit, in which the students intuitively attempted to look for Chinese equivalent for every English word they read. A shift from "word for word" to "concept for concept" paradigm significantly increased the reading comprehension. Many students began to show signs of "thinking in English." The second obstacle was the "lack of emotion habit", in which English descriptions did not incite the same feelings and emotions as did Chinese description with exactly the same content. This hampered the learning efficiency of the students significantly. It was shown that learning microbiology in English as a second language must be accompanied by shifts in learning paradigms and habits.
Learning and Teaching Biology: A Beginning Level Service Learning Based Course

Lee A. Abrahamsen*
Bates College, Lewiston, ME

A beginning level, microbiology/general biology course was developed as part of the biology curriculum at Bates College. The course offered a way for undergraduate students to investigate selected topics through the development and implementation of partnerships with local middle schools. The specific content areas for the course was chosen by the participating middle school teachers from a list of basic topics generated by the course instructor. All of the college students in the course were required to learn the principles, concepts, and vocabulary of all the selected topics. Small groups of 3-4 students each adopted a topic. Through additional (out of class) work with library and internet resources, the Bates course instructor and partner teachers, The undergraduate groups designed and helped teach curricular units and hands-on lab experiences based on their topics to the younger learners in the participating middle school classes. Assessment was based on college student engagement and performance, course evaluations, and teacher surveys. Overall, students were very satisfied with the course experience. Grades on a mid-term and final exam averaged 85%. Ninety-two percent of respondents said that the service learning component was one of the strongest features of the course. Ninety-one percent of the high school teachers considered the experience useful to their own learning and that of their students. Ninety percent considered the experience very worth their time and effort, and 100% said that they would do it again. The course was accepted to fulfill a requirement for the Biology major.
Bringing Case Studies to Life in the Introductory Microbiology Laboratory

Ruth A. Gyure*
Western Connecticut State University, Danbury, CT

The case study approach has long been successfully used in the teaching of microbiology, particularly in teaching about infectious disease. Here we propose a multi-week inquiry-based unknown investigation (simulated clinical sample) that presents groups of students with a challenging case to ponder and involves independent, active learning in the laboratory. Whereas this approach has often been used in higher level courses, we suggest that it is equally effective for teaching beginning microbiology students. The project focuses mainly on the gram-negative rods of the gastrointestinal tract and the clinically important gram-positive cocci. We also include, because of its significance, the non-enteric genus *Pseudomonas*. Students are given sheets with basic information about sample collection techniques and considerations, as well as reminders about types of organisms that are common causative agents. They then receive samples (either fecal, urine, wound exudate, or throat swab) and information about their patient. These truncated case histories are specifically designed to: 1) provide realistic information based upon clinical experience in our geographic and demographic area; and 2) reveal no laboratory diagnostic clues that will tip the students off before they actually do their own tests. At the end of the investigation, groups present their findings in oral and written reports and are graded on their ability to approach the problem logically and to explain their process to classmates in a similar manner. The presentations are further subjected to peer review. For instructors, case study examples are presented, along with additional examples available online. We provide some hints about preparing the simulated samples and organisms suggested for use. Also included are suggestions for reading assignments that can be used to enrich the topic and require students to integrate what they are learning with a current issue in microbiology research or applied practice. The project is a lively and engaging way to encourage group cooperation, strengthen understanding of enrichment, selection, and isolation procedures, allow students to apply learned diagnostic test skills, provide the traditional 'unknown' experience, and encourage logical, critical thinking and clear communication. We feel that the use of an inquiry-based project in lieu of a series of discrete lab exercises offers several advantages, as our observations have suggested and as measured in data collected on student response sheets.
We developed a series of web-based interactive exercises for students to investigate relationships among microbes by phylogenetic tree-building through multiple alignment of nucleic acid sequences. In these exercises, students choose two members from each of five groups of bacteria as well as an out group (*Saccharomyces cerevisiae*). They obtain the organisms' DNA sequences for 16S rRNA through the Ndjinn program accessible from the Biology Workbench, and align them. They then use the CLUSTALW program, which uses the neighbor to neighbor joining algorithm, to derive trees that propose phylogenetic relationships among the tested organisms. Students are asked to: (1) predict what the tree may look like if 3 archeans are added, (2) compare the resulting tree and the predicted tree, (3) explain why or why not and (4) identify the major phylogenetic groups in the tree generated from organisms in different phylogenetic groups. In the remaining exercises, individual phylogenetic units are removed singly from the tree analyses. Students are asked to predict and note whether the bacteria remain in the same clusters or segregate to other positions. We believe that this activity can serve as an introduction to major taxonomic groups of prokaryotes and their phylogenetic diversity. It requires students to develop critical thinking skills. It can also be a capstone activity allowing students to synthesize information after reviewing phylogenetic groups. Various assessment instruments were used after the completion of the exercise and most student responses were positive. (This exercise is developed as part of the BioQUEST workshop "Microbes Count.")