American Society for Microbiology

CONFERENCE FOR UNDERGRADUATE EDUCATORS

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Poster Session & Abstracts

An Educational Program of
AMERICAN SOCIETY FOR MICROBIOLOGY

University of Central Florida
ASMCUE 2006 Poster Presentations

Saturday, May 20
3:00 - 7:10 pm
Health and Public Affairs Building, Atrium

Poster presenters may set-up their posters between 12:00 – 3:00 pm, Saturday, May 20. All posters will be available for viewing from 3:00 – 7:10 pm. Authors will present their posters in one of three sessions: A, B, or C. Authors should plan to be at their posters during the appropriate presentation time listed below. Posters should be removed immediately after the final poster session.

A: 4:20 - 5:00 pm  B: 5:50 - 6:30 pm  C: 6:30 - 7:10 pm

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A.G. Darden¹, C. D’Huyvetter² and M. van Sickle². ¹The Citadel and ²The College of Charleston, Charleston, SC.

2-B
A Problem-Based Learning Strategy for Addressing Issues Related to Ethical, Legal and Societal Issues Flowing from the Human Genome Project
# M.D. Boyle¹ and D.M. Braxton². ¹Department of Biology and ²Religion, Juniata College, Huntingdon, PA.

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Mapping Student Learning Throughout the Collaborative Inquiry Process: The Progressive E-Poster
K. Takayama¹, J. Wilson¹ and C. Netherton². ¹School of Biotechnology & Biomolecular Sciences, The University of New South Wales, Sydney Australia, and ²Learning and Teaching Unit, The University of New South Wales, Sydney, Australia.

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Do Different Learning Styles Affect Course Outcome for Community College Microbiology Students?
M.F. Lux and S.H. Bryant. University of Southern Mississippi, Hattiesburg, MS.

5-B
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S. Vanchinathan. Sri Paramakalyani College, India.

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# M.A. Peteroy-Kelly. Pace University, New York, NY.

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# D.L. Wegman-Geedey. Augustana College, Rock Island, IL.

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Augmenting or Replacing Lecture-Based Teaching with Interactive, Student-Centered Pedagogy in an Introductory Biology Course
C.N. McDaniel¹, B. Lister², H. Roy³ and M.H. Hanna¹. ¹Biology Department and ²Anderson Center for Innovation in Undergraduate Education, Rensselaer Polytechnic Institute, Troy, NY.
9-C
An Exercise in Adaptation: Transforming Traditional Microbiology Courses into Hybrid-Delivery Formats
J.M. Green-Johnson and B. Muirhead. University of Ontario Institute of Technology, Oshawa, ON, Canada.

10-A
Effectiveness of a Web-Based Laboratory Course in Biology
* J.A. Herzog. Herkimer County Community College, Herkimer, NY.

11-B
Using the Transition of Learning to Guide Course Design
# W. Huddleston. University of Calgary, AL, Canada.

12-C
Lab Intensive Microbiology: Can Lectures Be Substantially Eliminated Without Loss of Affective and Cognitive Gains in a Microbiology Course?
# K.S. Jagger. Transylvania University, Lexington, KY.

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E.R. Sullivan, A. Margolin and F. Rodgers. University of New Hampshire, Durham, NH.

14-B
Teaching the lac Operon in Introductory Biology
# L. Roberts and K. Curto. University of Pittsburgh, Clapp Hall, Pittsburgh, PA.

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Mining Winogradsky Columns in the Introductory Microbiology Laboratory
D.S. Katz. Rogers State University, Claremore, OK.

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A.J. Reese. Cedar Crest College, Allentown, PA.

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# L.B. Regassa* and A.I. Morrison-Shetlar**. 1 Georgia Southern University, Statesboro, GA and 2 University of Central Florida, Orlando, FL.

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S.L. Martin and * P.D. Brown. University of the West Indies, Mona, Jamaica.

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* N. Cheeptham. Thompson Rivers University, Kamloops, BC, Canada.

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D.J. Stemke. Elon University, Elon, NC.
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S.M. Merkel. Cornell University, Ithaca, NY.

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J.J. Shaffer1 and J.M. Hornby2. 1University of Nebraska at Kearney, Kearney, NE and 2Lewis-Clark State College, Lewiston, ID.

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S. Mani, J. Boggs, M. Anderson and M. Jett. Walter Reed Army Institute of Research, Silver Spring, MD.

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M.P. Hoch. Penn State York, York, PA.

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C. Rios-Velázquez1, B. Hernández2, M.F. Rojas1, Y. Vega-Bonet1, P.T. Visscher3 and L. Casillas-Martínez2. 1University of Puerto Rico-Mayaguez, Mayaguez, PR, 2University of Puerto Rico-Humacao, Humacao, PR and 3University of Connecticut, Storrs, CT.

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* E.L. Lilly. University of Massachusetts Dartmouth, North Dartmouth, MA.

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* J.K. Leavey. Georgia Institute of Technology, Atlanta, GA.

30-C
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# * S.S. Strand. Meramec Community College, St. Louis, MO.

31-A
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L. Erbežnik1 and S.M. Carver2. Oakland Community College, Highland Lakes Campus1, Waterford, MI and Albion College2, Albion, MI.

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C. Chow and R. Kelly. Simmons College, Boston, MA.
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T.J. Burkett¹, J. Hewlett², M.J. Kurtz³, J. Pino⁴, L. Rehfuss⁵ and S. Wallman⁶. ¹The Community College of Baltimore County-Catonsville, MD, ²Finger Lakes Community College, Canandaigua, NY, ³Minuteman Regional Technical High School, Lexington, MA, ⁴Community College of Rhode Island, Warwick, RI, ⁵Montgomery County Community College, Blue Bell, PA and ⁶New Hampshire Community Technical College, Portsmouth, NH.

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L.M. Miller¹ and L. Rodriguez². ¹Rice University, Houston, TX, ²The University of Texas Health Science Center at Houston, Houston, TX.

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J. Kiely and R. David Bynum. LIGASE, Stony Brook University, Stony Brook, NY.

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# C. Cooper. Truman State University, Kirksville, MO.

37-A
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L. Losada. Trinity University, Washington, DC.

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B. Dexter Dyer. Wheaton College, Norton, MA.

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T. Shors¹ and B.J. Rylance². ¹Department of Biology and Microbiology and ²Department of Special Education. University of Wisconsin-Oshkosh, Oshkosh, WI.

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# L. Tuhela. Ohio Wesleyan University, Delaware, OH.

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R.P. Anderson. Ohio Northern University, Ada, OH.

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* A.M. Ciraj, P. Vinod, K. Rajani, K.L. Shobha and K. Ramnarayan. Melaka Manipal Medical College, Manipal, Karnataka State, India.
44-B  
**Team-Based Integrated Learning Approach: Teaching Microbiological Concepts to Allied Health Students**  
# T. Brandon and J. Reiser. New Mexico State University-Dona Ana Branch Community College, Las Cruces, NM.

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# M. Shuster. New Mexico State University, Las Cruces, NM.

46-A  
**Assessing the Use of Active Learning Strategies in Achieving Learning Goals in a Community College Microbiology Course**  
# P.A. Tranby. Riverland Community College, Austin, MN.

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**A Research-Based Approach to Teaching Bioinformatics: Microbial Genome Annotation and Metabolic Modeling Using the SEED**  
A.A. Best¹ and M. DeJongh².¹Department of Biology and ²Department of Computer Science, Hope College, Holland, MI.

48-C  
**Whole Genome Sequencing of Bacteria as a Research-Based Undergraduate Course**  

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**Use of Literary Works to Convey Disease Impact**  
# C.A. Oquendo. Metropolitan Campus, Inter American University of Puerto Rico, San Juan, PR.

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**Microbial Cultures Coupled with Digital Data Collection, Narratives and Animations: Can these Activities Improve Students’ Understanding of Cellular Respiration?**  
J. Reuter¹, J. Wandersee¹ and J.W. Bennett². ¹Louisiana State University, Baton Rouge, LA and ²Tulane University, New Orleans, LA.

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# P. Franklin. Piedmont Virginia Community College, Charlottesville, VA.

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**Using Clickers in the Classroom to Strengthen ‘Just in Time Teaching’**  
R.A. Gyure. Western Connecticut State University, Danbury, CT.

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**The MicrobeLibrary Website: What’s In It For You?**  
E.L. Suchman¹ and A. Chang². ¹Colorado State University, Fort Collins, CO and ²American Society for Microbiology, Washington, DC.

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55-A  
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M. Bahr and S. Bordenstein. The Marine Biological Laboratory, Woods Hole, MA.
Use of a Multi-Player Educational Digital Game for Undergraduate Medical Microbiology
J. Gnarpe¹, B. Bray¹ and B. Boufford². ¹ Department of Medical Microbiology and Immunology and ² Academic Information and Communication Technologies (AICT), E-Learning Group, University of Alberta, Edmonton, AL, Canada.

Using a Bioterrorism Simulation to Improve Select Agent Identification
* T.T. Meilander, S.L. Helfinstine and C.J. Woolverton. Center for Public Health Preparedness and Department of Biological Sciences, Kent State University, Kent, OH.

A How-To-Guide to Publishing in the ASM MicrobeLibrary’s Curriculum Collection
J.A. Cardinale. Alfred University, Alfred, NY.

Research as a Tool in Undergraduate Education
M.G. Watve, Abasaheb Garware College, Pune, India.

Using MicrobeLibrary to Visualize the Microbial World! How Visual Resources Will Change How You Teach!
A.C. Smith. University of Maryland College Park, College Park, MD.

Adding Podcasting and Streaming of PowerPoint Lectures to an Online Microbiology Course – Is it an Effective Learning Modality for Online Students and Helpful as a Supplement for Traditional Students?
R. Alisauskas. County College of Morris, Randolph, NJ.
1-A
A Constructivist Approach to Teaching a Research-Based Molecular Genetics Course: Development and Evaluation
A.G. Darden¹, C. D’Huyvetter² and M. van Sickle².
¹The Citadel and ²The College of Charleston, Charleston, SC.

Background: A constructive approach to teaching upholds the idea that students make sense of new information by integrating it with what they already know. Undergraduate Biology students have significantly higher student achievement, attitude and enjoyment in constructivist classrooms as compared to traditional lecture-formatted classrooms. An upper level Biology majors Molecular Genetics course was developed in which students were expected to construct their knowledge as they worked on a novel research project. To confirm that this was truly a highly constructivist environment an education-trained observer was invited into the classroom.

Methods: In the course, designed around the professor’s research, students read and discussed journal articles as they learned the general concepts and research techniques and participated in a guided inquiry project developing hypotheses and experiments. Assessment of constructivist teaching utilized three different published instruments.

Results: The structure of the Molecular Genetics course demonstrated extensive application of characteristics of constructivist teaching. During the course the students gradually increased their level of participation and investment in the course. The instructor began the process by asking delving questions; however students quickly proposed their own questions to challenge understanding demonstrating an ability to apply and extend concepts. Students learned the process of experimentation and investigation as a layering, questioning, re-evaluating, and additive practice, as the accumulation of their own science knowledge was constructed along the way. A topic particularly uncomfortable for students, the fallibility and changeability of scientists and the laboratory, was experience first hand, and discussed as part of the research-paper analysis.

Conclusion: A course building on the professors research and encouraging students to take an active role in their learning process was evaluated. This constructivist approach emphasizing the process of science rather than content fosters higher-level thinking while still ensuring that the students develop a deep understanding of sophisticated scientific content and concepts.

2-B
A Problem-Based Learning Strategy for Addressing Issues Related to Ethical, Legal and Societal Issues Flowing from the Human Genome Project
# M.D. Boyle¹ and D.M. Braxton². ¹Department of Biology and ²Religion, Juniata College, Huntingdon, PA.

A team-taught course entitled Genomics, Ethics and Society was developed and delivered during the fall of 2005. The course was designed for both science and non-science majors and was writing-intensive. The course was designed to achieve the following objectives:

- understand the basic concepts of modern genomics
- learn to situate modern genomics in larger cultural contexts
- learn to master a basic range of ethical theory
- conduct research on selected problems and apply ethical theories to particular case studies

At the center of the course were five problem-based learning (PBL) exercises performed in small groups (8-10 students) with a faculty facilitator. Each PBL was conducted over three one hour class periods. The cases were based on controversial issues in prenatal genetic screening; genetic discrimination in health insurance; use of genetic testing in awarding college scholarships; use of genetic information in solving a crime; and patenting of an AIDS drug and its use in third world countries. The hypothesis being tested was that the PBL format would engage students and at the end of the course they would feel more empowered to discuss current issues related to ethical, societal and legal issues related to molecular biology. The effectiveness of the approach is currently being evaluated using data collected from a pre and post-test online questionnaire developed by the Science Education for New Civic Engagements and Responsibilities (SENCER) organization. The goal of this organization is to promote educational programs employing rigorous interdisciplinary approaches to teaching basic science that strengthen students’ capacities to become engaged citizens. Thus the SENCER student assessment of learning gain (SALG) was selected as an appropriate assessment tool to evaluate the hypothesis. The results of this pilot study will be presented and discussed.
3-C
Mapping Student Learning throughout the Collaborative Inquiry Process: The Progressive E-Poster
K. Takayama\textsuperscript{1}, J. Wilson\textsuperscript{1} and C. Netherton\textsuperscript{2}.
\textsuperscript{1}School of Biotechnology & Biomolecular Sciences, The University of New South Wales, Sydney, Australia and \textsuperscript{2}Learning and Teaching Unit, The University of New South Wales, Sydney, Australia.

Students’ approaches to learning in the sciences are often predominantly content-centric, focused on skills acquisition and reportable outcomes. To better align the pedagogy of science with its professional practice, we created collaborative learning communities to emphasize ‘thinking about thinking’; i.e. the enhancement of learning through individual and group reflection and analysis of the scientific inquiry process. We have demonstrated the feasibility of this approach in a large, second year microbiology course of 280 students.

The progressive e-poster maps student learning through collaborative research in the lab, in which each team isolated a specific bacterial genus from an environmental sample. We created the web-based e-poster to provide a framework to facilitate critical reflection of the scientific process. The e-poster is distinct in purpose, format, and assessment practice from the traditional scientific poster. Students worked in teams to reflect on their scientific approach; critically develop scientific literacy; identify areas of uncertainty or concern; and discuss possible ways to address these issues. The “progressive” format underlines the iterative model of inquiry as the poster mapped the team’s experimental and reflective process.

Student perception of the research process shifted from an outcomes-focused approach to an iterative, reflective approach. The students’ intrinsic motivation developed in parallel with the emergence of collaborative learning communities. Qualitative evaluation of online discussion transcripts revealed peer learning and teaching, mentorship, and cross-disciplinary thinking. The e-poster provided a framework that structured the processes of cognitive transfer and application step by step, making them “visible” to the students.

Outcomes from the e-poster project provide guidelines to inform the development of: i) approaches to scaffold the process of scientific thinking; and ii) authentic assessment approaches for collaborative inquiry-based learning.

4-A
Do Different Learning Styles Affect Course Outcome for Community College Microbiology Students?
M.F. Lux and S.H. Bryant. University of Southern Mississippi, Hattiesburg, MS.

A study of forty-nine students enrolled in Microbiology at the Forrest County Center of Pearl River Community College (Hattiesburg, MS) demonstrated that there was no significant difference in outcome based on the correlation between the final course grade and the students’ self-disclosed learning styles. The final course grade was based on a 10 point scale, with the value of an “A” correlating with a course average of 90 - 100. The learning styles were determined from the completion by each student of a short survey, Learning Styles, developed by Colin Rose (www.chaminade.org/inspire.1earnstl.htm). The survey items were designed to indicate a preference for learning style in three categories (visual, auditory, and kinesthetic/tactile) based on a series of 27 questions in 3 distinct categories. Based on the original purpose to evaluate the relationships between grades and learning styles, the statistical data (2-tailed Pearson Correlation) revealed no significant relationship between grades and leaning style as the \( p \) values were greater than \( a = 0.01 \) for auditory, visual, and kinesthetic learning styles.

Successful students in the study, whether their final grades are “A”, “B”, or “C,” had similar learning styles. The laboratory component of the course may be an important factor in the success of the students who considered themselves visual or kinesthetic/tactile learners. However, few students who would earn grades of “D” or “F” in this course complete the semester. Most students are in programs that require a grade of “C” or better for their course of study. Students who have earned low grades on the tests and assignment at the beginning of the course typically drop the course before a final grade is given. The challenge for the future is to determine if the unsuccessful students have different learning styles and to modify the delivery to give more students a chance at successful completion of the microbiology course.
Microbial Enzymes are indispensable and widely used in Food and Pharmaceutical industries. Its hard to find any biochemical reaction without the mediation of enzymes. Although various bio produce enzymes, the enzymes isolated from the microbial origin plays a pivotal role due to their ease in isolation, affinity and activity. It can be illustrated with this example. A 1000 dm3 fermentor with Bacillus subtilis can produce up to 20kg of enzyme in 12hours, where as the quantity of renin enzyme extracted from the one calf stomach is about 10 grams and it takes several months to produce by one 50kg calf. Thus the impact it has over the economy is tremendous. Amylase constitute a class of specific group of industrially important enzymes that takes the 25% of enzyme market.

Soil consists of myriads of microorganisms with enormous enzyme potentiality. The experimentation primarily starts with the screening for the amylolytic bacteria in garden (preferably the wet soil).Then the maximum enzyme producer, Bacillus licheniformis in 12 hours is isolated on the starch agar plate. Once the physiological and biochemical reactions of the organisms are screened, the selected enzyme producer is incorporated to the suitable fermentation media with controlled conditions such as pH, temperature and aeration. The fermentation media is studied further for the separation, collection and purification of enzymes. The same organisms are exposed onto Ultraviolet radiations at the regular intervals. The Growth pattern of the mutated organisms is monitored and incorporated to the fermentation media. The efficiency of enzyme obtained from both wild type and mutated type can be studied further after their immobilization on sodium alginate and their reaction with suitable substrate solutions. Aeration and agitation found to play a significant role in the increased productivity of enzymes (Tonkova et al., 1993) in Bacillus licheniformis

Please Note: This is a thesis work of a single student (myself) and this can be effectively assigned to a group of 5 students with the focus on different type of enzymes and various substrate. About 1 litre fermentor can be used to collect enzymes and the immobilised beads can be reused with the efficiency of 87%.
Development of Measures to Assess Students’ Questioning Skills

# D.L. Wegman-Geedey. Augustana College, Rock Island, IL.

Development of questioning skills is critical for students planning to attend graduate school and equally important if one is to attain the goal of lifelong learning supposedly established through senior capstone programs. A capstone course in applied microbiology was “backwards designed” to include assignments and peer assessment work aimed at development of inquiry skills. Qualitative and quantitative tools were devised to assess students’ questioning skills by modification of existing methods.

The tools chosen for assessment of students’ questioning skills were:
- Calibrated Peer Review (CPR) an on-line system for evaluating written work through peer review
- coding of student questions displaying different levels of ability based on prior inquiry research projects by Paoletti and by Greene
- and open-ended questions to gather affective information about student perception of the learning experience.

Existing CPR assignment banks at http://cpr.molsci.ucla.edu/ did not address development of questioning skills so a new module was created, including three calibration essays. A coding system was developed using keyword, phrase and structural component analysis to assess levels of student questions. Questionnaires to gather affective data were developed on SurveyMaker, an online resource available on the intranet at Augustana College.

This poster describes the three assessment tools in more depth than above, and handouts of the new CPR module, coding system, and student perception survey will be available. Preliminary coding data suggest that once students are able to recognize the different levels of questioning skills (e.g., good research questions are often chained or clustered and routinely lead to additional questions), structured assignments can be used to help them improve. Results from the student perception surveys and CPR work suggest that as students become more self-aware, they become more self-guided in the process. This project is part of the 2005-06 ASM Scholars-in-Residence program.

Augmenting or Replacing Lecture-Based Teaching with Interactive, Student-Centered Pedagogy in an Introductory Biology Course

C.N. McDaniel¹, B. Lister², H. Roy¹ and M.H. Hanna¹. ¹Biology Department and ²Anderson Center for Innovation in Undergraduate Education, Rensselaer Polytechnic Institute, Troy, NY

An instructor-centered pedagogy of lecturing was replaced by a student-centered computer-based technology at Rensselaer. Unique materials were developed for each session to include the following: Pre-class activities include simulations, data analyses, readings, reviews (quiz), and essay questions that set up in-class activities. In-class concepts are explored in interactive discussions, tutorials, simulations, or Web-based exercises done as individuals and in groups. Learning is monitored and enhanced by concept queries. Lecture is marginalized. Peer and active learning predominate. Post-class activities use similar formats to review or extend the body of knowledge. Student learning increased in this format over the lecture-based format. Five different faculty members have taught the class (11 sections, ~60 students per section). Pre-instruction concept inventories varied among sections from ~37% to ~50% correct answers and did not correlate with the proportion of majors in the sections (% majors varied from 5 to 95%) indicating little difference in knowledge between majors and non-majors at the beginning of the course. Our course has no prerequisites and is required. The learning gains of the weakest students improved the most by the end of the semester. The end-of-semester learning-gains were similar when compared between sections and instructors and at least twice as high as the learning gains from a lecture-based course. Identical hour exams, used each semester but changed from one semester to the next, have similar averages between sections. Initial results show student-centered methods utilizing an identical set of materials leads to effective learning of biological concepts with little instructor influence in an introductory biology course without prerequisites.
9-C  
An Exercise in Adaptation: Transforming Traditional Microbiology Courses into Hybrid-Delivery Formats  
J.M. Green-Johnson and B. Muirhead. University of Ontario Institute of Technology, Oshawa, ON, Canada.

Adaptation of microbiology courses for specific programs is an issue recently addressed by the ASM. A key challenge is honing material to meet needs of specific programs while maintaining a strong foundation in microbiology. We hypothesized that transforming "standard classroom format" microbiology courses into a hybrid delivery format would allow us to meet this challenge for students in two distinct programs: allied health and biological science. Key goals were to increase flexibility and control over learning time by students, and to facilitate acquisition of essential microbiological concepts. Two hybrid courses in microbiology were developed using various pedagogical strategies to blend online and face-to-face instruction. Face-to-face classroom time was reduced by 50% and replaced with weekly online instruction including online multimedia lectures with accompanying online exercises, tutorials, and a course website containing core material built around the theme of antimicrobial activity, "Microtheme cards" and an online "journal club" for research paper presentations. Learning assessment included both online and in-class testing, evaluation of written assignments and online presentations. A student feedback survey was used to obtain student’s views about the hybrid pedagogy used in the two courses. Challenges faced included the diverse audiences for the two courses, dealing with the issue of self-motivation for students and maintaining “high frequency” online contact. Outcomes: Hybrid delivery allowed for increased flexibility in terms of student’s ability to view and review content. Preliminary assessment indicates improved student performance with the hybrid format. We found student feedback to be positive and participation in on-line activities to be high, leading us to believe that the hybrid format provides many opportunities to meet the needs of students in both programs.

10-A  
Effectiveness of a Web-Based Laboratory Course in Biology  
*J.A. Herzog. Herkimer County Community College, Herkimer, NY.

Online degree granting programs have flourished, but in many cases a stumbling block remains: successful completion of one laboratory science course before graduating. Many students cannot be on campus 5 to 6 hours per week for such courses. Although web-based laboratory courses exist, most use virtual exercises that may not allow for acquisition of basic skills and techniques. In order to replicate the on-campus environment, I developed an online general biology course with an accompanying hands-on laboratory component. It is open to traditional and non-traditional students, is for non-majors and as on campus is capped at 25 students. The online course is offered asynchronously using Lotus Notes, and all work is presented, submitted and evaluated electronically. Virtual discussions facilitate both class and laboratory learning. The on-campus course has no web enhancement and all work takes place in class. In order to determine the efficacy of this novel course, I attempted to maintain continuity in the instructional content and presentation throughout both courses. In doing so, I was able to quantitatively compare retention rates as well as final and laboratory grades. I also performed a qualitative analysis of student participation, submissions and synthesis of information. A grade of B or better was attained by 43% of on-campus students and the median grade was a C. Online, 62% of students achieved a B or better and the median grade was an A. Overall, the online students significantly outperformed their on-campus counterparts in all parameters. One must note, however, that the retention rate of online students averaged 58% versus an 89% rate on-campus. In conclusion, it appears that innovative techniques such as laboratory discussions, hands-on laboratory activities and digital movies employed in this web-based course are effective. Based upon the data, it is also evident that this course is self-selecting: only the most hard-working and dedicated students remain enrolled. I am currently addressing if increased exam times and more precise discussion grading procedures will enhance overall performance of on-camp students.
Course Design

11-B
Using the Transition of Learning to Guide Course Design
# W. Huddleston. University of Calgary, AL, Canada.

The transition of learning is the transfer of knowledge, skills and experiences from one learning environment to the next. With every new learning experience, the transition of learning increases as the students acquire additional information that builds on their previous knowledge. When setting and assessing course objectives, undergraduate educators need to consider both the level of knowledge and range of skills students have entering a course and their aptitude upon course completion. As part of the process of redesigning both a first and second year microbiology course, measuring the transition of learning identified topics and skills that need introduction and development in the first course, and enhancement in the second course.

Students entering the second course took an entrance exam to measure their ability to recall knowledge and laboratory skills learned in the first course. A comparison was made between the results of this test and the exit exam they took at the end of the first course. The students also completed an entrance and exit survey to identify how they have used their knowledge and skills since completing the first course.

Students who experienced inquiry-based labs to collaboratively design experiments testing hypotheses about open-ended questions in their first year or who independently used the knowledge and skills from the first course in out-of-class research projects recalled the information and proper technical skills more accurately than students who were not actively applying the knowledge and skills.

These results support findings that use of knowledge and skills in both inquiry-based laboratory exercises and independent student projects increases the deep learning of content. The redesign of the first course needs to eliminate the emphasis on materials that promote and require the memorization of non-critical content and increase the recursive use of conceptual knowledge and essential skills. Students will use an “experimental design worksheet” to collaboratively develop testable hypotheses and think critically about experimental design. They will need to build and use skills continuously throughout the term to carry out independent research projects, collect and analyze data and present their findings to colleagues in both written and oral formats, which will be assessed using a rubric focused on acquisition of concepts rather than specific content. The redesign of the second course needs to further encourage the students to use and develop these authentic research skills.

12-C
Lab Intensive Microbiology: Can Lectures Be Substantially Eliminated without Loss of Affective and Cognitive Gains in a Microbiology Course?
# K.S Jagger. Transylvania University, Lexington, KY.

Do students improve their attitudes, cognition and application of the scientific process in a lab intensive microbiology course that moves from directed experiments to open ended projects with minimal lecture time? Active inquiry has long been known to enhance student learning. The most active, inquiry-driven activities in many science courses often take place in the laboratory setting. Yet, most science courses still schedule at least as much classroom as lab time each week. The microbiology course under study met three times per week for 2 hour blocks which could be used for either lecture or lab activities. Most were used for laboratory activities. Early in the semester the labs were more directed; as the semester progressed emphasis was placed on more open ended, independent projects. Surveys were administered early in the course (week 5) and at the end of the course (week 13). Anonymous group informal feedback on teaching was used to determine how students perceived the course relative to other science courses, how the activities helped students think about the process of science, how the lab influenced student learning, and how students felt about the limited lecturing in the course. At this point virtually all of them wished for more lecture time. Yet, many indicated the labs helped them apply and integrate concepts from their textbook rather than simply memorize. At the end of the semester, students were also asked to characterize the progression of independence in lab, and the usefulness of the required weekly lab reflections and lab notebooks in promoting understanding of microbiology. At this point 5/8 students indicated they would not reduce the time dedicated to lab and half the students felt the weekly lab reflections facilitated their learning. Finally, a range of attitudes and student perceptions about learning in the course were assessed using a Likert scale. In these responses 8/8 agreed that the course made them feel more like a working scientist. Currently, a coding rubric to evaluate changes in cognitive sophistication and scientific literacy as reflected in writing assignments (weekly reflections and lab notebooks) is in development.
13-A
Germs 101: Design of a Large Microbiology Course for Non-Science Majors
E.R. Sullivan, A. Margolin and F. Rodgers.
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Germs 101 is a team-taught course with 230 students that is offered every semester to fulfill a science, general education requirement. Our objectives for the course are to educate the general citizen on how dramatically microbes influence our everyday lives, and to help students make informed decisions where microbes are involved. We are also conscious of not fuelling the perception that science is an intimidating subject. Much of the course is taught using current events or topics that we can relate to students’ everyday lives, and covers a broad range of material from “germaphobia” attitudes to staying healthy, sexually transmitted diseases, concerns about antibiotic resistance, and the search for extra-terrestrial life. Team-taught by three faculty with different expertise, the course is divided into three general sections: “Germs in your Pants” (pathogenic microbiology with emphasis on individual diseases), “Germs as Partners” (environmental and industrial microbiology), and “Germs Lurking” (public health microbiology with emphasis on preventing disease transmission by examining personal habits). Our teaching philosophy is that we try to minimize lecturing and maximize group activities and the use of the instant wireless response system (“clickers”; by eInstruction) to survey students’ attitudes and access their knowledge. Grading is heavily based on frequent Blackboard quizzes and activities that include a hand-washing experiment, looking up personal vaccination records, bathroom and food-handling surveys, finding five famous people that died of five different infectious diseases, and designing a menu of food items made with the help of microbes. Response to the course has been overwhelmingly positive by the students, with interest in enrollment always exceeding class capacity and strong end of semester student evaluations. Since the course’s clientele and method of teaching are comparatively different to teaching a class of science majors, we faculty genuinely enjoy the change in format and know that our efforts are beneficial in broadening the microbial awareness and knowledge of the general public.

14-B
Teaching the lac Operon in Introductory Biology
# L. Roberts and K. Curto. University of Pittsburgh, Clapp Hall, Pittsburgh, PA.

The ever-increasing tide of information in the biological sciences has forced students (and instructors) to pay only cursory attention to most topics in introductory biology. This breadth of coverage may be in conflict with the requisite depth required for students to succeed in upper division courses such as advanced cell biology, microbiology and genetics. The objective of the current work is to highlight one of the crucial foundational concepts in introductory biology and to make it viscerally understood by students.

The project involved the redesign of the unit on prokaryotic gene expression. Although the second semester course covers genetics, evolution and ecology, we decided to confine ourselves to a single topic for the purposes of this research. The class of 250 was first presented with the standard lecture on gene expression. This was followed by an activity that incorporated the operon functions as part of a factory-management business plan in the recitation for that week.

In each of the four recitation sections, students (in groups of 3 or 4) were first presented with several possible scenarios and then asked to determine which of these was most similar to graphic representations of the lac and trp operons. Each scenario shared the premise that the students, as factory managers, needed to develop a way to optimize production while minimizing energy and resource wastage under differing physical constraints.

Assessment of the effectiveness of the combined lecture/recitation activity is based on (a) a genetics pre-test on the first day of the semester, (b) a more focused pre-test immediately preceding the operon lecture, (c) collection of students’ writing from the recitation activity, and (d) inclusion of pre-test questions on the mid-term exam, to assess gains in knowledge.

The results of the present project will contribute to the development of further activities and tools designed to highlight additional foundational topics in introductory biology.
Hand-on Projects

15-C
Mining Winogradsky Columns in the Introductory Microbiology Laboratory
D.S. Katz. Rogers State University, Claremore, OK.

This work examines whether an open-ended project is effective in teaching essential microbiological techniques while also stimulating student interest in microbiology. Traditionally, microbiology techniques are taught through a series of unconnected lab exercises, providing little opportunity for students to practice critical thinking skills. Winogradsky columns are often used in courses to demonstrate the stratification of microbes according to their metabolic characteristics. Most Winogradsky protocols limit observations to visual observation of strata development accompanied by microscopic observations from various layers. For my undergraduate microbiology course I have developed an open-ended semester-long group project centered on the construction and study of Winogradsky columns. At the beginning of the semester, groups create their Winogradsky columns after selecting variables to test and generating an hypothesis. In addition to visual observations, students use traditional techniques to characterize organisms from the columns including motility determination, plate counts, staining procedures (e.g., Gram, endospore and acid fast stains), pure culture establishment, and bacteriophage isolation. Formal group lab reports include discussion of the data obtained throughout the semester and are illustrated with annotated videos, digital camera stills and drawings. Formal and informal evaluations are used to determine competence in performing techniques and to assess the use of critical thinking skills such as hypothesis testing. Evaluation methods include direct observation of laboratory technique, assessing team discussions of results, grading of written individual and group lab reports, and student self-evaluations of team member contributions. The final formal group lab report is evaluated using a rubric described in this report. Student attitude is assessed through both informal discussions and a final questionnaire. I conclude that this project is effective in teaching general microbiology techniques, while having a positive effect on student understanding and appreciation of microbiology.

16-A
A Four-Part Approach to an Adopt-A-Microbe Lecture Project
A.J. Reese. Cedar Crest College, Allentown, PA.

An Adopt-A-Microbe project (100 points, ~10% final grade) was designed to enhance student comprehension, interest in microbial diversity and metabolism, presentation opportunities, and creative learning. Students in this course for science majors adopted an organism and researched classification, structure, nutrition and ecology, metabolism, and societal impact. Individual student learning of the material was assessed by:

1. A poster to teach key points to their peers. Students took notes from posters to learn microbial diversity content (25 points, instructor assigned).
2. A press release to share their microbe’s impact with the general public and ensure sufficient understanding of the material (25 points, instructor assigned).
3. A report detailing what they found on the above topics to have a more familiar report component of the project (25 points, instructor assigned).
4. A written or hand-made creative project to help them and others remember the microbe for both fun and student ownership of the project (25 points, peer evaluations).

The project was effective in these areas: positive project reaction, microbial diversity appreciation and interest, originality in press releases and creative projects, student ownership of work, and poster session practice. The project was less effective in helping the students understand microbial metabolism (as demonstrated on the following exam). Previous attempts at diversity coverage had less student involvement and comprehension. Outcomes suggested that while microbial diversity was appreciated and student involvement achieved, future versions of this project require more student guidance on report and poster preparation and more assistance in making connections about microbial metabolism.
17-B
Assessment of Learning in a Project-Based Molecular Biology Curriculum
# L.B. Regassa¹ and A.I. Morrison-Shetlar².
¹Georgia Southern University, Statesboro, GA and ²University of Central Florida, Orlando, FL.

One of the biggest challenges that students face in molecular microbiology is understanding how and when to use the techniques that they learn to answer novel scientific questions. Teaching molecular biology techniques in a sequential fashion allows students to learn the individual techniques, but they often have difficulty moving beyond this rudimentary understanding. The goal of this two year NSF-funded project is to help students bridge the gap between knowledge and application of molecular concepts using hands-on, project-based learning. The course was presented within the framework of a research cloning experiment that students completed in the laboratory. At the end of the course the students generated their own research proposals. This approach was appropriate for our department, where undergraduate students play an integral role in faculty research programs. The protocols for the course were adopted primarily from the NSF-sponsored Unraveling DNA text (M.R. Winfrey et al., Prentice-Hall), and adapted to serve a student populace dominated by rural, first generation college students at a predominantly undergraduate institution. Adaptations included integration of the laboratory and lecture experience and modification of all laboratory exercises to update the approach and/or use a more cost-effective alternative. Learning was assessed over two semesters using pre-/post-test content questions, student self-evaluations, focus groups, class observations and numerous writing assignments (e.g. one-minute papers, research notebooks, mini-grant proposal). Students indicated a high satisfaction level with this type of learning environment, as they felt empowered to learn and significantly increased confidence in their abilities by the end of the course. Analysis of student learning indicated substantial mastery of content and retention of the material throughout the semester and identified particular concepts that students found challenging. Overall, the results indicated that project-based learning was an effective method for enhancing student learning and application of molecular microbiology concepts.

18-C
Wastewater Treatment: An Experimental Approach Using Model Systems

Water and wastewater treatment are commonly covered topics in an introductory microbiology course. If laboratory study covers these topics, it may involve a field trip to a local sewage treatment facility. Students rarely get the opportunity to look at treatment of waste and the physiological parameters of the process in an experimental format. In a three week laboratory experience focused on wastewater treatment, groups of students developed a testable hypothesis, designed and carried out an experiment to test their hypotheses, and formally presented their results using PowerPoint to their peers. Students used a Carolina™ Wastewater Treatment Kit, BOD equipment, and coliform testing methods. Other types of equipment (spectrophotometers, pH meters, and digital imaging) were also available for use. Student projects included: “The Use of Plants to Remove the Coliform E. coli in a Wastewater Treatment Model,” “Green Alternatives to Wastewater Treatment,” “Efficiency of a Trickling Filter System v. an Activated Sludge System in the Reduction of BOD,” and “Biofilms and Surface Area: An Experiment in Secondary Wastewater Treatment.”

When students were independently surveyed as to the most useful aspects of experimentally studying wastewater using the equipment, the responses suggested three descriptive domains: an increased understanding of the class material, experience with designing experiments and collecting data, and appreciation for having the equipment available. Students indicated that learning to use the equipment was uncomplicated; however, the directions to upload data from the BOD equipment were unclear. Students also noted that a greater number of model systems and BOD equipment would allow greater leeway in experimental design.

The purchase of the wastewater treatment kits and BOD systems was funded by a grant from the National Science Foundation Division of Undergraduate Science Education, CCLI award #0126817, Integrated Study of Environmental Effects on Organisms.
19-A

Antimicrobial Activity of Some Actinomycetes Isolated from Plant Leaves in Jamaica
S.L. Martin and * P.D. Brown. University of the West Indies, Mona, Jamaica.

As part of the laboratory exercises in a final year microbiology course, students isolate antibiotic producers from the soil. This exercise was expanded as a problem-based undergraduate research project to enhance the student’s experience in applied and environmental microbiology, and to develop important research skills. In this project, the student isolated actinomycetes from the leaves of various local plant species and determined the range of their antimicrobial products.

The one-semester exercise covered principles ranging from basic techniques of aseptic techniques to applied concepts such as partial purification of ‘novel’ antibiotics. Actinomycetes isolated were characterized on the basis of colony morphologies, and by their growth and/or use of various biochemicals. Primary screening was done by the perpendicular screening method against bacteria (Gram positive and Gram negative) and yeast. Secondary screening was carried out by disc diffusion using ethyl acetate extracts of the supernatants. Minimal inhibitory concentration (MIC) determination was also carried out using the macroscopic dilution method. Antimicrobial substances were active against Gram positive bacterium (n=3), Gram negative (n=2) and yeast (n=2). Similar results were obtained in secondary screening, although no extract was active against the yeast. These results were similar those obtained with the antibiotic gentamicin. MICs for all extracts were > 1 mg/ml.

This project gave the student valuable hands-on experience in isolating actinomycetes from a non-traditional environment, and using various biochemical and microbiological tests for bacterial identification and antibiotic effectiveness. Furthermore, it involved conducting systematic observations, documenting findings, interpreting and analyzing data, drawing conclusions, and communicating results. Finally, it enabled the student to get a ‘real-world’ appreciation of the difficulty in finding novel antimicrobial agents to deal with the global problem of antimicrobial resistance. The feedback from the student suggests that this comprehensive study gave a greater understanding and appreciation of the application of applied and environmental microbiology.

20-B

Tempeh Production as an Introductory Session to Food Microbiology in an Introductory Microbiology II Laboratory at TRU
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At Thompson Rivers University (TRU), students majoring in a new Cellular, Molecular and Microbial Biology (CMMB) take two 200-level core introductory microbiology courses with associated laboratories. These labs are being developed to include experiments and field trips related to medical, environmental, molecular and industrial microbiology in an effort to communicate the diversity of basic and applied microbiology. The purpose of this study was to evaluate a new lab exercise in the food microbiology unit in which Tempeh production via fungal soybean (solid state) fermentation is carried out.

The educational goals of this exercise are that students will recognize the role of microorganisms in both traditional and modern food microbiology. Students will also learn to use techniques taught to investigate a fungal starter and related aspects of its growth conditions, building on the basic microbiological lab skills laid in earlier foundational lab exercises. Tempeh production is an excellent exercise to enforce these learning outcomes as it has long been used as a staple source of protein in Indonesia.

For this exercise, students are divided into groups and work together on soybean preparation, inoculation of starter culture (Rhizopus oligosporus), incubation (at 30°C for 36 to 48 hrs), and observation of starter for both microscopic and macroscopic morphologies. To study sporulation, growth of starter on YM plates incubated for 48 hrs and 5 days, and growth of the fungus in the soybean batch, are monitored. At the end of the two-week lab, Tempeh purchased from a local natural food store is visually and microscopically compared with student-produced product. In addition, Tempeh is cooked and provided for them to taste. After the session in the winter semester 2006, students were surveyed for the usefulness of the lab content and how it enables them to learn about microbial products and their impacts on our daily life. The survey data indicates that they both enjoy working on this lab and learn more about fungi and diversity of fermented food products. Details, pictures of the lab, and survey data are presented here.
21-C
Use of a Portfolio in a General Microbiology Class to Add Content Flexibility
D.J. Stemke. Elon University, Elon, NC.

One of the many challenges to teaching a general microbiology course is finding pedagogical methods that effectively cover content for diverse students needs. As a typical microbiology course will have students whose microbiology interests include medicine, pharmacy, nursing, dentistry, ecology, food sciences, and molecular biology, satisfying all students' interests can be difficult. Typically, material covered in a general microbiology class is loosely structured around a general microbiology textbook, which deviates into subject topics the instructor deems are important, and includes subject matter necessary for success in the laboratory. While this type of organization develops well-trained and well-rounded microbiologists, adding a portfolio is an effective way to individualize and add depth to the course.

One way to structure the portfolio is to provide opportunities for students to explore a variety of microbiology resources divided into three components. In the first component, students are required to complete ten short writing assignments. They can include a wide variety of subject material such as conducting interviews with microbiology professionals, visiting businesses or labs that use or identify microbes, summarizing or reviewing relevant secondary literature, book chapters, videos, or web sites, and attending pertinent seminars at regional universities. The second component of the portfolio requires students to review approved primary literature. The final component of the portfolio is a reflection on the relevance of the portfolio to each student's career interests.

Evaluation of the portfolio is assessed by a rubric based on the difficulty and quality of the material completed, assessment of reflective thought, and demonstrates clarity in the written assignments. Based on student comments in course evaluations, the opportunity for students to pursue their individual interests by means of a portfolio has shown to be an effective and popular addition to a general microbiology course.

22-A
Four Inquiry-Based Labs: Do They Help Students Learn Experimental Design?
S.M. Merkel. Cornell University, Ithaca, NY.

There are many reports and studies calling for more emphasis on developing higher-order thinking skills in science classes at all levels. Within the framework of a laboratory course, this often means moving from so-called "cookbook" labs to discovery or inquiry-based labs. This poster presents 4 cookbook labs that were converted to discovery-based labs after the author attended a 2005 ASM-CUE workshop by S. Lauffer, entitled "Un-cooking the Lab." Each lab begins by presenting a group of 4-6 students with a question (LAB 1: Where do bacteria live? LAB 2: What are the limits to growth of some bacteria? LAB 3: What causes crown gall disease? LAB 4: What promotes and inhibits biofilm growth?) and a list of available supplies. Each group designs an experiment that answers the question using the supplies on the list. Limiting the supply list makes management of the open-ended experiments feasible in a lab class with over 100 students.

Students are encouraged think about controls and treatments, appropriate and comparable sampling methods, and data analysis. An instructor reviews each design and meets with each group to discuss comments and changes. Students carry out their experiment during lab time, but with little direct supervision, when the supplies are available. After results are gathered and analyzed, each student writes up a final lab report for their grade.

My hypothesis was that these labs would enhance students' ability to design experiments. To test this, the preliminary design plans were evaluated based on a rubric that looked for a clear hypothesis, complete and reasonable methodology, a description of controls and adequate data analysis. Preliminary results show a progressive improvement in experimental design over the course of the semester. Student comments indicate that they enjoy designing experiments in groups. We have found that groups of 3-4 students work well; groups of 6 tend to allow some students the opportunity to sit back and not participate. However, because each student turns in a report, they still have to know what is going on. In addition, students appreciate the opportunity to choose questions that they found interesting, rather than being told what to do.
23-B
Mapping Student Learning Throughout the Collaborative Inquiry Process: The Progressive E-Poster
J.J. Shaffer and J.M. Hornby. 1University of Nebraska at Kearney, Kearney, NE and 2Lewis-Clark State College, Lewiston, ID.

Quorum sensing has been shown to be a common phenomenon in bacteria, and several laboratory exercises have been created to expose students to this concept. Little has been done to demonstrate the importance of quorum sensing in fungi. The dimorphic fungus Candida albicans has become the model organism in this area of study. This fungus is easy to grow, important in medical settings, and the quorum sensing molecule (farnesol) is inexpensive and readily available. Quorum sensing in C. albicans acts to regulate the morphological switch between budding yeast and mycelia. Students score the quorum sensing response by quantifying the amount of cells that are budding versus those that are forming mycelia using a phase contrast microscope.

For the laboratory exercise, students are provided with basic information on quorum sensing in C. albicans. They are asked to develop a testable hypothesis and to design an experiment on the quorum sensing response of C. albicans under varying environmental conditions. Students may look at the effects of temperature, quorum sensing molecule concentrations, cell concentration, serum, and plant extracts on the morphological response of C. albicans. The biological assay can be completed within a 3 hour laboratory session. Students are then asked to prepare a lab report and explain the results that they obtained.

This exercise provides students with increased information on fungal quorum sensing, allows them to design an experiment and explain their results, enhances critical thinking and problem solving, and provides application-based experience in basic microscopy. Student feedback has shown that inquiry-based laboratories in microbiology are successful alternatives to the typical technique-driven labs. Technical training does not have to be separated from inquiry-based learning in microbiology courses.

24-C
What Kind of Cooties Do I Have? An Innovative Learning Module for Introducing High School Students to Infectious Disease Microbiology
S. Mani, J. Boggs, M. Anderson and M. Jett. Walter Reed Army Institute of Research, Silver Spring, MD.

Of utmost importance to both the health professional and consumer is a fundamental understanding of infectious disease microbiology. This module introduces advanced high school, allied health and general science students to microbial identification through mock case studies. These studies involve: specimen collection from different sources, sample processing, performing biochemical tests and finally identification of unknown microorganisms using a sample dichotomous key. The identification results were confirmed with the use of rDNA sequences. This module is divided into lesson plans which integrate introductory microbiology, aseptic technique, collecting biological specimen samples, plating and culturing samples with several types of media (basal, enriched, selective, differential), and then identifying and differentiating the grown bacteria based on colony appearance and Gram staining. In addition, students learn about antibiotics, antibiotic resistance and the use of common spices in antimicrobial control. This model was field tested by approximately 100 student interns at the Walter Reed Army Institute of Research (WRAIR) as well as at two local high schools as part of their biotechnology curriculum. Student learning is assessed through written reports and oral presentations while teacher feedback is reported through anecdotal comments and a displayed eagerness among the students to continue the module. This module was developed at the WRAIR to meet teacher requests for an authentic laboratory to enrich the traditional didactic learning and memorization that characterize microbiology instruction. Since this module is classroom based and has not been imposed by external agencies, formal student statistics chronicled by central administration will not be available until June 2006.
**25-A**

**Investigation of Coral Disease within Bacterial Biofilm Communities**  

A 16 week project was developed to give practical microbiology training in the context of coral microbial ecology. This offered an attractive alternative to classes used to teach these methods, as it offered ecological relevance. Training included methods in bacterial isolations, culture, molecular methods (e.g. PCR) and bioinformatics (DNA sequence alignments). During the project the student was able to develop a novel hypothesis of bacterial biofilm pathogenesis interactions on coral. The study was assessed as a report in the form of a high impact peer review journal and an oral presentation, as part of the final degree examinations.

Bi-weekly supervisory meetings and practical results were used to assess progress via:

1) Maintenance of isolates in culture (diseased coral surface biofilms)
2) Isolate identification using molecular methods
3) Determination of environmental triggers (e.g. temperature and salinity) for expression of inhibitory compounds between strains.

The ecological context proved engaging and added value to the learning experience well beyond that of equivalent laboratory classes for these methods. Outcomes of this approach included a new hypothesis regarding the role of coral bacterial biofilms in pathogenesis and sustained, high levels of motivation and participation from the student, who gained high grades for both the formal report and oral presentation. Student feedback underlined the importance of the practical ecological context of the project in maintaining motivation.

Extension of this approach: Data analysis between institutions running a parallel project would allow a more robust bioinformatics approach towards bacterial community analysis. This project was an extension of a summer studentship funded by the Society for Microbiology, UK.

**26-B**

**16 SrDNA and Metagenomic Inquiry-Based Activities to Enrich Learning of Microbial Diversity**  
**M.P. Hoch.** Penn State York, York, PA.

Microbial ecologists have advanced the knowledge of prokaryote diversity in every habitat explored on Earth via the application of molecular tools largely focused on 16 SrRNA genes (16 SrDNA), and recent metagenomic databases allow the analysis of diversity *in silico* for any gene of interest among non-culturability microorganisms. Two inquiry activities were incorporated into a microbial diversity course to enhance the teaching of these molecular approaches and concepts of diversity and evolution. Denaturing gradient gel electrophoresis (DGGE) was chosen to study diversity of 16 SrDNAs because it allows simultaneous comparison of multiple samples in addition to exposing students to DNA extraction from environmental samples and PCR amplification. The 16 SrDNA diversity profiles of environmental samples were compared before and after enrichment cultivation or other treatment to illustrate shifts in community structure in response to added selective pressures. Students also learned to use basic bioinformatics tools through searching a metagenomic database for a functional gene or protein of ecological relevance. Students queried sequences of known prokaryotes of broadly diverse taxa and then used these to search unknown sequences in the NCBI, BLAST with environmental sample data. After multiple sequence alignment of known and unknown sequences, dendrograms were constructed to explore phylogeny of the unknowns. Functional gene or protein results were compared with a 16 SrDNA phylogram constructed of their chosen known prokaryote taxa to reinforce concepts of prokaryote evolution. In addition to written research reports and class discussion on both activities, student learning of concepts and techniques was assessed by quizzes on similar lecture content prior to the activities and then again afterwards. The effectiveness of these activities in student learning as opposed to lecture content alone was further assessed by written survey and discussion. Exemplary student projects and assessment results will be presented.
27-C
Geology, Ecology, Molecular Studies (GEMS) at the Cabo Rojo Salterns Microbial Observatory
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1University of Puerto Rico-Mayaguez, Mayaguez, PR, 2University of Puerto Rico-Humacao, Humacao, PR and 3University of Connecticut, Storrs, CT.

A Research for Undergraduate Institute (RUI) for studies in Geomicrobiology has been established within the Cabo Rojo Salterns Microbial Observatory. This RUI include undergraduate students from the Biology Department at the University of Puerto Rico (UPR) Humacao and their counterparts in the Biology and Geology Departments of the UPR-Mayaguez. One of the gages of success of our ongoing project is the multidisciplinary nature of the research teams assembled composed of students with Microbiology, Marine Biology, Biotechnology and Geology backgrounds. To teach students from such diverse backgrounds, we use hypersaline microbial mats as our key educational tool. The colored layers of the mats help the students understand that different microorganisms live and interact within hypersaline ecosystems, playing important roles in the geology of the sediments. For a deeper understanding of the diversity of the cultivable and non-cultivable microorganisms present in the mats layers, we have conducted two intensive workshops. The first one was based on the general microbiological aspects of the cultivable microbes present in the mats. The students inoculated pieces of mats in plates containing different C sources, salinities, and pH's in the presence and absence of oxygen. After incubation, the students were able to observe how different microbes emerge from the mats. To determine the diversity of non-culturable microorganisms, a genetic engineering and molecular microbiology workshop was conducted. Students learned how to extract genomic DNA from the mats layers, amplify the 16SrDNA and other genes related to specific physiologies to ultimately relate their taxonomic and metabolic traits. As assessment tools, a pre-post test including open and closed questions, one minute paper and group discussions were used during the workshops. According to the results, an increase of 42% from the pre (47%) to the post (89%) tests was obtained after the student’s participation in the workshops, indicating conceptual achievement in the learning process about the microbial community structure within the mats.

28-A
Use of the Temperature-Sensitive Mutant Serratia marcescens D1 in a Series of Laboratory Exercises: Bacterial Genetics, Quorum Sensing, and Antibiotic Production
* E.L. Lilly. University of Massachusetts Dartmouth, North Dartmouth, MA.

Serratia marcescens produces a red pigment, prodigiosin. The pigment is also an antibiotic compound with production regulated by quorum sensing. The D1 mutant is temperature sensitive; colonies grown at 25°C are dark in color while colonies grown at 37°C are transparent. Here, I describe a series of experiments that utilized these features of Serratia marcescens D1 to expose students in my General Microbiology course to a variety of concepts.

Serratia marcescens was introduced early for morphology and culturing experiments. Later, students studied genetic regulation with a temperature-dependant expression study. Pigment production from regulated by quorum sensing was observed with streak plates. A second exercise in quorum sensing used a spectrophotometer to detect prodigiosin produced at different cell densities. To study the antibiotic effects of prodigiosin, students were provided with cultures of S. marcescens D1 grown at 25°C and darkly pigmented and grown at 37°C and thus very lightly pigmented. Students extracted prodigiosin and determined relative concentrations using a spectrophotometer. Next, sterile antibiotic test disks were dipped in each extract and an ethanol control, dried, and tested against a variety of organisms for antibiotic activity.

Laboratory reports included an opinion section, detailing the effectiveness and intelligibility of each exercise with relation to the entire course. Students completed surveys at the end of the semester regarding the S. marcescens experiments and the other laboratory exercises. The S. marcescens exercises ranked among the most helpful lab exercises for understanding course content. Further, most students felt the use of this organism throughout the semester enabled them to build on a knowledge base from week to week. Students felt an increased interest level in the S. marcescens exercises due to familiarity with the organism and the prodigiosin system.
29-B
Detection of the Phenazine Biosynthetic Operon as a Novel Way of Teaching PCR
* J.K. Leavey. Georgia Institute of Technology, Atlanta, GA.

Pyocyanin, a blue phenazine compound, is easily visible diffusing from Pseudomonas aeruginosa colonies on Mueller-Hinton agar plates. Observation of this pigment in our introductory microbiology lab course led to an in-class discussion of pyocyanin and its role as a virulence factor in chronic lung infections of cystic fibrosis patients. Because of this discussion, we replaced our “cookbook” PCR exercise with a PCR-based assay for detection of phzF, a gene whose product is a key enzyme in the pyocyanin biosynthetic pathway. Primers were designed to amplify a short (159bp) region of phzF, and P. aeruginosa and E. coli DNA were used as templates. The protocol was simple and despite limited experience with micropipettors, 5 out of 10 lab groups visualized PCR products when P. aeruginosa DNA was used as a template.

A course survey was administered at the end of the semester and included a question on the effectiveness of individual exercises performed during the course. Survey results indicated that significantly more students felt they learned “a lot” from this exercise than from 11 other exercises derived from a commercially available laboratory manual.

Several factors may have accounted for positive student feedback on this exercise. Unlike the exercises from the manual, the students were involved in the design of this exercise. The students also may have felt more connected to the results because the exercise stemmed from an in-class discussion. However, we can not rule out that the students felt they learned more from this exercise because of the technique itself. This PCR exercise was one of only two exercises in the course utilizing molecular techniques.

We have recently redesigned our introductory microbiology lab course to include a semester-long project on Pseudomonas. We plan to assess the effectiveness of our new project-based lab course in increasing student learning.

30-C
A Cooperative Inquiry Approach to Identify Bacterial Specimens Increases Student Satisfaction but Does not Change Content Learning in an Undergraduate Microbiology Laboratory Course
# * S.S. Strand. Meramec Community College, St. Louis, MO.

In an attempt to increase content learning and facilitate discussion, a unit on the identification of an unknown bacterial sample was made into a cooperative inquiry activity through several key modifications. Students were grouped into teams of six, and conducted/analyzed all experiments as a team. Each student received an unknown and the identification was done in two phases. In the first phase, students tested the unknown in several sets of experiments that were predetermined (tests of intra/extracellular enzymes, tests on selective/differential media etc), and were part of the general laboratory curriculum. Based on the results from these experiments, students used a schematic to identify the genus of their organism. In the second phase, after doing some individual reading and research, students designed and conducted additional experiments to identify the species. Each team submitted their proposed experiments for approval. Since each student identified one unknown organism, the characterizations were in depth, and often included information such as susceptibility to antibiotics/disinfectants. In both phases, team discussion and interpretation of results was required and several team assignments were collected. Quantitative and qualitative data was collected using performance on exams, and coded responses to survey questions to measure content learning, and student satisfaction respectively. Compared to previous semesters, students spent more time collecting, interpreting and discussing test results. Student performance on lecture exam questions reinforced through the laboratory was not significantly different (p value 0.5) from performance on questions from the lecture content alone (83% and 78% respectively, of questions answered correctly). A number of students, 80%, indicated satisfaction with the cooperative inquiry method. These data suggest that students have a positive learning experience using this cooperative inquiry method, however additional modifications are necessary to demonstrate that such a method increases content learning in microbiology.
The Use of Fluorescence In-Situ Hybridization (FISH) for Detection of Fecal Coliforms as an Undergraduate Microbiology Laboratory Exercise
L. Erbežnik and S.M. Carver, Oakland Community College, Highland Lakes Campus, Waterford, MI and Albion College, Albion, MI.

Fluorescence in-situ hybridization (FISH) is a powerful molecular technique, yet it has been seldom used in an undergraduate microbiology laboratory curriculum. Undergraduates have traditionally learned to detect fecal coliforms by using selective media with an incubation period up to 48 hrs. Rapid, sensitive, and versatile, FISH-- when used as a laboratory exercise linked to the relevant lecture material--would enhance student understanding of fundamental concepts of molecular microbial ecology. With this goal in mind, we have adapted two previously published FISH protocols into a prototype exercise for our curriculum and laboratory setting. Briefly, we designed an oligonucleotide, ECO1018 (nucleotide positions 1018-1036 in the \textit{Escherichia coli} 16S ribosomal RNA), which was labeled with CAL Fluor Red 610 (IDTDNA, Inc.). Aliquots of mid-log cultures of \textit{E. coli} and \textit{Enterobacter aerogenes} were filtered onto polycarbonate filters and fixed with 95% ethanol for 10 min. After short pre-hybridization at 55°C, the cells were hybridized in a formamide buffer with EUB338 (a universal phylogenetic probe for bacteria) and ECO1018, in parallel with 4'-6'-diamidino-2-phenylindole (DAPI) treatment, followed by a 37°C wash, which removed non-specifically bound probe. As expected, both \textit{E. coli} and \textit{E. aerogenes} cells were lit up with DAPI and EUB338, whereas only \textit{E. coli} was was detected upon hybridization with ECO1018, demonstrating the high specificity of that probe. The entire procedure, excepting bacterial growth, can be completed within 90 min, when cells are ready for epifluorescence microscopy. This undergraduate microbiology laboratory exercise can be incorporated into a variety of microbiology courses (e.g., food, environmental, medical) and expanded into a multi-week student-designed inquiry project. The effectiveness of learning fundamental concepts such as microbial phylogeny, oligonucleotide design, nucleic acid hybridization, and epifluorescence microscopy and their applicability in real-life scenarios will be evaluated by exams with problem-solving questions, performance assessment, and attitude surveys.
32-B
Collaborative Project between Honors Biology Students and Elementary Teachers in Urban Schools to Develop and Deliver Science Curriculum
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As an alternative assessment, first year students enrolled in the honors section of the introductory biology course were asked to teach urban ecology, cellular structure and function, or biochemistry as related to food and nutrition, first to elementary science teachers in an in-service course, and then to develop and deliver a lesson to elementary school children in either K-1, or 4-5th grades. Students received feedback as they developed lessons appropriate for urban classrooms. These curricula were then compiled and disseminated to the teachers.

The rationale for this project is four-fold. 1) Teaching is the best way to learn a topic. 2) The ability to communicate the information to various audiences demonstrates facility with a subject. 3) This experience will induce some students to consider teaching as a profession. 4) In the least, this exercise will dispel some of the myths about public schools and their students.

Students were assessed by the content and delivery of both presentations, and the final written curriculum that includes specific learning objectives as they relate to the Massachusetts standards in Science and Technology, a 25-35 minute classroom activity, appropriate discussion questions and answers, as well as a short “extension” activity. Student’s attitudes towards the project were assessed through a reflection piece. Students thought the project challenging and intimidating at the beginning but in general found the overall experience “surprisingly” positive. Additionally, some elementary school teachers who were not comfortable teaching science gained familiarity with the various topics, and welcomed the tested lesson plans that they can implement.

33-C
The Northeast Biomanufacturing Center and Collaborative (NBC²): A Hands-On Approach to Biomanufacturing Training
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As the biotechnology industry matures, it has become increasingly concerned about the availability of workers that can operate at the intersection of biology, chemistry, engineering, and regulatory affairs that the production of biopharmaceuticals requires. In order to address this need, The Northeast Biomanufacturing Center and Collaborative (NBC²) was created. The purpose of the center is to facilitate the development of biomanufacturing specific training programs. The center operates through regional “hubs” that serve local schools and industry within their region, disseminate curricular materials, and host training seminars in biomanufacturing specific skills.

Biomanufacturing is a unique discipline that integrates more traditional academic disciplines. The educational plan that we have developed is to teach supporting topics, such as microbiology, through prerequisite courses and to integrate laboratory skills, such as the microbial gram stain, in the context of a manufacturing campaign.

This educational plan is supported by a curricular approach that focuses on hands-on activities in a simulated manufacturing / production environment. For example, protein assays, microbial identification, bioreactor operation, protein isolation, endotoxin assays and other techniques are all integrated in a capstone manufacturing course where students produce CGMP compliant recombinant proteins. Of central importance is the use of documentation (Batch records, SOP’s, product specifications) and QC /QA procedures that are proscribed in the CFR’s.
**Outreach**

**34-A**  
**Effective Outreach Materials to Teach Microbiology to Middle School Students**  
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For microbiologists who are looking for ways to engage in community outreach, the MedMyst materials provide a extensively tested and teacher-endorsed method for learning. The Center for Technology in Teaching and Learning, in consultation with an expert panel of scientists, 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 through hands-on classroom activities. All of the outreach materials (multimedia games, classroom activities, and a topic specific magazine are available free in on the web site (http://medmyst.rice.edu). A Spanish version of the multimedia component is also available. The project is funded by two NIH Institutes--National Center for Research Resources and the National Institute for Allergy and Infectious Disease.

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 multimedia 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, the results of a recent national diffusion study will be presented. These data indicate that teachers adopt the MedMyst materials for their classes largely because of the quality of the activities and their alignment with the National Science Standards. The presentation will emphasize the complementary hands-on labs that undergraduate or graduate students or faculty members could freely share with middle school teachers through workshops or classroom visits. Sample activities will be demonstrated.

**35-B**  
**Teaching Teachers using Microbiology**  
J. Kiely and R. David Bynum. LIGASE, Stony Brook University, Stony Brook, NY.

Current Topics in Microbiology, a course at Stony Brook University, is directed at pre-service secondary school teachers. We use laboratory activities, videos, on-line resources, group work and lectures to develop a better understanding of biology and scientific inquiry. Student learning is assessed through laboratory reports, a group project and traditional objective exams. Microbiology is well suited to helping secondary-school science teachers explore, experience, and practice the fundamental skills of science as they develop tools for teaching. Our students have earned or are pursuing an undergraduate degree in a biological science (average g.p.a. of 3.2), but have limited experience with experimental design and data analysis. Laboratory activities use organisms selected from http://www.science-projects.com/safemicrobes.htm, this allows the students to increase their confidence in the laboratory as they design experiments, prepare reagents and analyze their own results. Developing the students' skills in data presentation is a key goal of this course; therefore, as the semester progresses the students take increasing responsibility for deciding the format for data presentation in the laboratory reports. Course content is based on Core Themes for Introductory Microbiology Courses (ASM), and The New York State Living Environment curriculum for secondary schools. Each unit is introduced with a video from the Intimate Strangers series and supplemented with reading assignments from on-line resources and scientific journal articles. Working in groups of 3 to 5, the students prepare a scholarly presentation of a controversial topic related to microbiology. The students are expected to give a balanced view of both sides of controversies such as the hygiene hypothesis or the mutagenic risks of disinfectants. This combination of activities leads the students to recall and reexamine material learned in introductory biology courses as they come to a better understanding of key themes in biology and prepare to teach.
36-C
Impact of Service Learning and Community Engagement on Learning in a Sophomore Introductory Microbiology Course

# C. Cooper. Truman State University, Kirksville, MO.

The study reported here consists of an evaluation of the impact of embedding a service-learning (SL) project into an allied health major’s Introductory Microbiology course. The majority of the students were in their second year of a bachelor of science in nursing program at Truman State University, a public liberal arts university. The impact of adding SL to the course was assessed using a standardized course evaluation instrument provided by the IDEA Center (Individual Development and Educational Assessment) Student Rating System (www.idea.ksu.edu).

The strength of the project is two-fold 1) historical data exists from IDEA course evaluation surveys on the course taught without SL from 2001-2005 and 2) the IDEA surveys address students’ perception of their learning in a comprehensive way. The IDEA survey results include data items such as student attitudes, excellence of teacher, and progress on objectives such as factual knowledge, principles and theories. Additional data is provided on factors that affect student progress on objectives such as, stimulated student interest and fostered student collaboration. The IDEA survey results will be in progress at the time of the ASMCUE meeting, hence, only the instrument itself and a summary of the items that relate to SL will be presented.

The SL project involves bacteriological (coliform) analysis of untreated rural water in a community with multiple concentrated animal feeding operations. A reflective survey instrument (and data) will be presented that was designed to assess SL experiences among courses at the Truman campus. Students, faculty, and community partners will contribute to the reflective analysis of the SL project experience to provide feedback on learning, teaching, and community benefits, respectively. The reflective surveys will augment the findings from the IDEA instruments and taken together, will allow the instructor to make appropriate adjustments to the SL project to improve student learning and satisfaction with the course.

37-A
Novel Approach to Independent Research Projects for Urban Underrepresented Minority Students Using Community Based Research

L. Losada. Trinity University, Washington, DC.

One of the most difficult aspects of teaching General Microbiology is getting students to conduct meaningful and gainful independent projects. In the past, we have asked students to select a topic from a more general area in microbiology and to design and conduct the experiments in the lab. The results from the project have been deficient at engaging students into doing research and testing their critical thinking skills. Keeping in mind the current student population, all female and 80% underrepresented minorities, a novel approach to introduce community based research (CBR) was designed and will be implemented in Fall 2006. The students will conduct an independent project within the overarching topic of water microbiology of the Anacostia River and a poster session will be held at a town meeting in Southeast DC. In addition, students will act as team-leaders of a small group of middle-school girls to collect the data for their research project. Because a large number of our students come from Washington, DC, that research will have a relevance and connection to their lives which may engage their interest. The students’ level of engagement will be assessed from prompted research journals. By allowing college seniors to act as mentors they will need to be very well versed in the project (underscoring the academic rigor) and their role as models for younger girls will enhance the way they view themselves and their knowledge. The students’ self-perception will be assessed from the research journals and pre and post-experience surveys. The students’ academic performance will be tested on written exams, and during their interaction with the community at the poster session. The results from exams and posters will be compared to those from Fall ’05 which did not incorporate the CBR. I hypothesize that this approach which shows students the collaborative aspect of research and gives the students the opportunity to use their knowledge to impact a local community and other individuals at the same time, will prove successful in exciting urban minority young women into science careers and research in general.
We describe the curriculum redevelopment of the Moorpark College Industrial Manufacturing Biotechnology Program. The purpose is to improve student participation and retention in the program to more effectively address our dual mission of transfer education and workforce development.

This program trains students for careers in industrial manufacturing or for transfer to university degree programs. Declining enrollments necessitated a reassessment of the curriculum. In a collaborative effort between the Central Coast and the State Biotechnology Centers, Moorpark and Ventura Colleges, and the Workforce Investment Board, local biotechnology industry was surveyed to assess workforce needs. Additionally, interviews and focus groups were conducted with key industry employees, human resource officers, and the college’s Biotechnology Advisory Board to clearly specify the knowledge and skills industry desired.

Curriculum was developed that incorporated the results of the industry needs assessment, and included both theoretical knowledge as well as skills-based courses. Focused on student learning, the curriculum was tiered - starting with basic, entry-level courses and building to advanced levels. Woven throughout the courses were soft skills such as teamwork, strong verbal and written communication skills, good work ethics, hands-on lab skills, and the ability to troubleshoot a process. The exit knowledge and skills for each course was determined from the needs assessment.

Career pathways were established with local high schools and ROPs. A Tech-Prep Consortium was formed to evaluate the options of dual enrollment, enhanced articulation, and student incentives as potential strategies for student recruitment.

The desired outcomes, improved student participation and retention, will be assessed by enrollment numbers. The development of entry-level curriculum and incrementally building students' knowledge and skills will improve student success. Motivation and feelings of self-efficacy will be enhanced, resulting in the desired program outcomes. The ultimate assessment will be student marketability and job performance.
39-C
Considering Sympatric Speciation as Not the Exception: Bacteria as Model Organisms for Evolution
B. Dexter Dyer. Wheaton College, Norton, MA.

Great progress has been made in understanding bacterial evolution. Genomic analyses in conjunction with collections worldwide have provided many refinements to bacterial phylogenetics. However most evolutionary theory continues to rely upon the activities of macroscopic, terrestrial, sexual organisms. The concepts, terminology and emphasis of most teaching units on evolution have not caught up with the importance of bacteria and the ways in which bacteria differ from the usual models. For a case in point, look up “bacteria” in the index of almost any text or trade book on evolution to see how limited the discussion has been.

Bacteria differ profoundly from the usual model organisms by being:
- the majority and most diverse of all organisms
- not especially morphological
- asexual, yet “promiscuous” via horizontal transfer
- intimate with and acutely responsive to their environments (including each other)

Allopatry, requiring geographical isolation of sexual populations, has been considered the usual or only mechanism for speciation. Sympatry typically is dismissed as a rare exception or non-existent. However, the “rare” exceptions are revealing:
1. Selection for intimate relationships within symbioses (e.g. some insect/plant associations) Bacterial communities may be even better examples.
2. Aquatic organisms (e.g. cichlids of African lakes) which appear not to follow the allopatric “rules.” Bacteria may be better examples of the complexities of aquatic living.
3. Asexual organisms are sometimes acknowledged as not fitting the allopatric model and many evolution texts treat asexual organisms as exceptional!

Goals: (1) to illustrate examples of bacteria as significant examples of sympatric speciation, thought to be rare by evolutionists who focus only on macroscopic, sexual species (2) to introduce ideas for more bacteriocentric examples of speciation for the lecture classroom. These include the accessible model systems of M. Travisano (e.g. Travisano and Riley, 2000 American Naturalist Suppl. 156) and R. Lenski (e.g. Cooper et al 2000 Nature 407:736-39) that could enhance lectures and discussions on bacterial metabolism. For example, cross-feeding and other metabolic trade-offs appear to strongly influence the collective metabolisms of bacterial communities. Such examples may enrich more traditional discussions of bacterial metabolisms as isolated examples.

40-A
Utilizing Avian Influenza Role-Play to Encourage Microbiology Learning in Non-Science Majors
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Motivating non-science majors to study scientific material challenges many University instructors. Presenting pure, undiluted scientific information frequently leaves students unable to recognize relevant information and unmotivated to learn it. Later, the students often ask, “Why do I need to know this?” and “What does it mean?” In this study, two professors introduced the topic of influenza to 150 non-science majors via an informative but humorous role-play. That role-play resulted in a series of thoughtful responses from students including, “What would happen if human cases of avian influenza were reported in the U.S. today?” and “How do we prevent the spread of human-to-human influenza?” Information, alone, rarely impacts people’s views or behaviors; but personal experience often does. Role-playing, like other good inquiry approaches, transforms informational content into experiential learning. Educational research has established that role-plays serve to (a) encourage an interest in material, (b) set the stage for complex definitions, relationships, and analyses, and (c) establish the informational relevancy (Chinnici, Yue, & Kieron, 2004). Role-plays effectively link science to daily life for non-science majors. Microbiology role-playing scenarios were used to teach pre-nursing students about infectious diseases, their transmission, prevention, and treatment. Positive written feedback from the students indicated that the role-play exercise provided a useful learning experience that can be adapted to other topics and courses.
Conversation, Concepts, and Connections: Use of In-Class Student Discussions to Promote Student Learning and Connection of Concepts in Microbiology

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Students in introductory microbiology lectures often do very little thinking during class and are expected to do most of their thinking and learning in isolation from faculty and peers. Students can memorize facts alone but making connections between concepts is more difficult, resulting in failure of deep understanding. The goals of this study were 1) for students to take a greater ownership of their educational experience by thinking and learning more during lecture and 2) to learn if small, in-class discussions allowed students to understand a greater depth of content by facilitating connections between interdependent concepts. A personal response system (PRS) was used in two ways to elicit student feedback and stimulate discussions. The first use, designed to promote ownership of learning, initially posed questions prior to lecture. Students saw what they retained from assigned reading prior to class and what key issues to look for during lecture. After lecture, the same questions were again asked. In questions where <50% of students answered correctly the first time, an average increase of 45% was observed in correct answers after lecture. Secondly, the PRS was used to promote class discussion and connect topics by presenting a question for students to first answer alone, followed by persuasive conversations with their neighbor, and then re-testing. Bloom’s Taxonomy was used to write questions ranging from basic metabolism and genetics topics to synthesis questions involving knowledge of both topics. These questions were later included in exams. Data indicate that students learned from the discussion (8% answering correctly before discussion and 39% answering correctly after) but continued to think about the concepts while studying on their own (77% answering correctly on imbedded exam question). Student surveys indicated that 92% of students felt that class discussions helped them learn and think more during lecture. These data indicate that small, in-class discussions can promote student learning and thinking and help students make connections between material from different units.

Analysis of Teaching Strategies to Develop a Global Perspective in Microbiology

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The purpose of this study was to evaluate the effectiveness of several teaching strategies used to develop a global perspective in microbiology. A global perspective requires students to understand and apply their knowledge of other cultures, religions and socioeconomic systems to the solution of microbiological problems. The class was an introductory microbiology class for allied health students. Class size was 65 students. Global perspective issues were integrated into course lecture material, cooperative learning groups and one class period was used for a guest speaker who presented real-life examples of health care issues from experiences working with orphaned children in Haiti. A student’s understanding of a global perspective was assessed through an analysis of answers on case study problems as part of midterm and final exams. Results indicated that compared to integration of global perspectives in lecture using invited speakers who could provide personal examples of health care challenges in an underdeveloped country (obtaining uncontaminated water; lack of consistent electricity; treating orphans with HIV, TB, measles and malaria; lack of basic medical supplies in hospitals, etc) significantly decreased student’s erroneous assumptions that global health care is similar to that in the US (P<0.001). Student performance on case studies showed a 3-fold decrease in answers that indicated a lack of understanding of the challenges of health care in underdeveloped countries. The addition of two cooperative learning groups analyzing case studies significantly improved (P<0.01) a student’s ability to develop culturally appropriate solutions to disease outbreaks.
43-A
Enhancing Active Learning in Microbiology Among Undergraduate Medical Students through Case Based Learning (CBL) Sessions
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Case based learning (CBL) is an interactive student-centered exploration of real life situations. This paper describes the use of CBL in teaching microbiology for medical students during second year of the undergraduate medical program at Melaka Manipal Medical College, Manipal, India.

The microbiology curriculum is divided into four blocks of approximately 10 weeks duration. Cases for CBL sessions were identified before the commencement of each block. These were factually based problems written to simulate real life situations. The case sheets with history and relevant findings were made available to the students during commencement of each block. In each block, students had six CBL sessions of 3 hours duration.

During presentation sessions, the class was divided into four groups and a faculty member from the department of microbiology was identified as a facilitator for each session. Students were asked to present the learning objectives individually. Role of the facilitator was limited to keep students focused on learning objectives and to ensure group dynamics. Topics discussed during CBL sessions were evaluated by including these contents during block examinations.

In a cross-sectional survey conducted to assess the effectiveness of CBL, majority of students responded that, apart from helping them acquire knowledge in microbiology, CBL sessions also enhanced their analytic, collaborative, and communication skills. We also compared, the average score obtained by the students for all CBL portions in block examinations with the average scores they had obtained in lecture topics. The examination scores in CBL topics were significantly higher than those obtained for lecture topics.

Our experience indicated that CBL sessions enhanced active learning in microbiology. More frequent use of CBL sessions would not only help the student gain requisite microbiology knowledge but also enhance analytic and communication skills.

44-B
Team-Based Integrated Learning Approach: Teaching Microbiological Concepts to Allied Health Students
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Students preparing to enter allied health professions have difficulty connecting course content to application, or so-called "connecting the dots". This situation can be frustrating for them, especially when their topic of study is a course like microbiology. Traditionally, lecture and lab are taught separately, though the intent of the lab exercises is to facilitate the process of making connections between lecture content and application.

Research studies have shown that learning is greatly enhanced when students work in teams, and that if the course is structured to integrate content and application, students will acquire critical thinking and problem-solving skills, and be better at relating and synthesizing general concepts to specific applications.

Students work in teams on a semester-long laboratory project to identify and characterize six unknown bacterial organisms. The project is designed to integrate and align the learning objectives of the course to the lab exercises, while at the same time stimulating curiosity about the unknown organisms. At the completion of each project component, students post the required information to an electronic poster, and present the results along with a conclusion. The four components of the team lab project include:

a) Microscopic morphology, differential staining, pure culture isolation, and atmospheric oxygen requirements;

b) Identification of unknown bacterial organisms;

c) Microbial control-disinfectants and antibiotics;

d) Clinical significance and public health issues.

There is evidence to suggest this approach does provide an effective means to help students learn. First, a significant 10% increase in the comprehensive final exam grades from previous semester reflects improved learning of microbiological concepts. Second, a survey of student learning and confidence, conducted at mid semester and at the end of the semester, showed that student ratings of satisfaction (scale 1-10, 1 being lowest, 10 being highest) on Confidence, Motivation, Satisfaction, and Curiosity (8.1); Understanding and learning of difficult concepts (8.2); and Team-work improved learning (7.5).

Third, the first exam average class grade for this current semester showed 8.2% increase from the previous semester. Fourth, the electronic poster presentation of the integrated team-project reflected an increase in learning of microbiological concepts by students' ability to make connections and draw inference of theory and application.
Integrated content modules, in which applications are closely linked to the underlying foundational material, are hypothesized to enhance student learning both by provoking interest in, and enhancing retention of, foundational content knowledge. In a typical microbiology course, foundational knowledge (e.g., cell wall structure and synthesis) is presented early in the course, but applications requiring this knowledge (e.g., cell wall active antibiotics) are often not introduced until late in the course. By separating the necessary background from the corresponding applied material, students are not offered immediate reinforcement (e.g., through an illustration of its relevance) of the foundational material.

In this descriptive study, a pre-nursing microbiology course was re-designed around five integrated content modules. Each module attempted to introduce foundational material and then immediately introduce practical applications that build on this basic information. Additionally, a common progression through each module was adopted. This involved “bracketing” the module with a brainstorming introduction and a “capstone” culminating assignment that reinforced the connection between the content of the module and a real world scenario.

Assessment of students’ impressions of this approach was carried out using end-of-semester written evaluations. Students were asked to describe their perceived learning from each of the modular assignments, as well as from the course overall. Analysis of student impressions will provide insight into one aspect of the effectiveness of this approach (i.e., student attitude), as well as provide guidance on development of effective assignments to both maximize learning and engagement in this population of students. A separate analysis of content mastery will be carried out in the future.

The context and rationale for the research question relates to my (anecdotal) experiences and the documented national trend in the overall under-preparedness of community college students, especially in the sciences. The community college mission, focusing on open access and fostering student success, thus places unique pressures on the science faculty. In face of the current nursing shortages and exploding demand for more nursing graduates, the problem of the under-prepared Associate Degree nursing student is a daily challenge in the microbiology classroom. Many of these students are highly motivated Licensed Practical Nurses (LPNs), who have tested into the second year of Registered Nursing coursework. These LPN students often lack both the didactic and skills background necessary in college-level science. The research question was geared to developing a study to assess the effectiveness of alternative learning strategies for these students, as measured by outcomes, in microbiology. The goal was to help these students be more successful in mastering the key concepts in the course. I began by establishing five primary learning goals that anchored the learning expectations for the course. I chose one goal initially to focus on, and this goal addressed the concepts important for understanding the need for aseptic techniques including the requirements for the transfer and growth of microorganisms and infection control. A variety of active learning techniques were developed or chosen and used to reinforce learning. These active learning techniques included case study analysis, cooperative group work (especially on quiz questions), and “hands-on” techniques such as puzzle construction and analysis, among others. A course assessment established the students’ mastery of the concepts and skills prior to beginning instruction. Qualitative and quantitative post-course outcomes assessment indicated an overall improvement in student learning in comparison to previous semesters. Students were also asked to suggest changes in the course that would help future students be more successful at meeting goal expectations. Five changes that may further benefit student learning in the goal area are currently being incorporated into the course, and will be analyzed from an outcomes-based assessment perspective. These changes are:

a) Restructure lab to more closely align to lecture.
b) Restructure lab to remove repetitive, low-value exercises like repeated Gram staining and include/enhance labs more directly linked to the 5 learning goals i.e. water testing, soil testing, sensitivity testing, etc.
c) Set up a microbiology lab tour of a hospital/clinic facility –plans in progress for tour of (larger) Mayo Clinic facility and (smaller) facility i.e. Austin Medical Center.
d) Utilize more active learning strategies in content/lecture presentation to improve learning goal mastery and retention.

Restructure lab biochemical testing so it is more pertinent and more focused on learning goals.
A Research-Based Approach to Teaching Bioinformatics: Microbial Genome Annotation and Metabolic Modeling Using the SEED

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According to the Genomes Online Database, there are currently over 1300 microbial genome sequencing projects underway or completed. Organizing and interpreting these data is essential, and is the purview of biology, computer science and statistics – disciplines that come together to form the field of bioinformatics. As microbiologists, we are uniquely positioned to open the field of bioinformatics to students in a biological context, since no area of biology has been more impacted by genomics than microbiology. We implemented a two-semester, project-based bioinformatics course to seize this opportunity.

The course is driven by ongoing research projects of faculty members; we are actively developing a genome annotation tool called the SEED. Our goals in this course are to: model interdisciplinary research; bring together students from multiple departments; and expose students to two areas of bioinformatics – genomics and metabolic modeling – and aspects of microbiology in a hands-on manner. Students should become aware of details of bioinformatics research as well as the broader impact of this discipline on biology. We use a single, 2-hour class period per week to introduce concepts in bioinformatics, demonstrate tools instrumental to project work, set out project goals for groups of students, and assess progress toward weekly goals. The majority of the work occurs outside of class time; students are required to meet with instructors weekly outside of class. Assessment through student surveys and project reports indicates that we have fulfilled most of our learning goals. In its first offering, we have students from the computer science, biology and chemistry departments. Students gained the experience necessary to make individual contributions to a complex bioinformatics research project. One concern expressed by students was that exposure to the breadth of bioinformatics was limited due to the focus of the research project. As we look to a second iteration of the course, we believe that our initial course model can be refined to highlight more effectively the connections of the project to broader aspects of bioinformatics and biology.

Whole Genome Sequencing of Bacteria as a Research-Based Undergraduate Course


The BIO 2010 report challenged undergraduate institutions to prepare the next generation of researchers for the changing direction of biology that increasingly integrates advanced technologies, digital information, and large-scale analyses. To answer this call, the University of Florida is offering this spring semester an innovative and research-based undergraduate course entitled, “Bacterial Genome Sequencing.” The course objectives are to learn about the dynamic field of genomics through the process of entirely sequencing a previously unpublished bacterial genome and to learn about the process of original research, including communicating results. The students work collaboratively to sequence, assemble, and annotate the Enterobacter chloacaes P101 genome with the goal of publishing a manuscript that lists all of them as authors.

The course meets biweekly and is structured as a 50-minute lecture followed by a 2-hour laboratory session. With the exception of two activities, all of the research is computer-based and taught in a computer lab. Whole genome sequencing is feasible within the framework of a one-semester course as a result of a recently purchased high throughput DNA sequencer that significantly reduces the cost and time of genome sequencing versus standard automated sequencing technology.

We are assessing student progress by two exams based on concepts presented in lecture, two practical exams that include activities like designing primers, using the BLAST database, assembling sequence fragments into contigs, and two writing assignments. As writing a research paper is a significant objective of this course, we introduced students to primary literature in bacterial whole-genome sequencing very early in the semester and use examples from the literature throughout the course.

We will present the outline and structure of the course, results of our bacterial genome sequencing project, exam outcomes, and the results of our pre and post course questionnaire which asks students to rate their knowledge and interest in genomics, sequencing strategies, etc. before and after completion of the course.
Use of Literary Works to Convey Disease Impact

C.A. Oquendo. Metropolitan Campus, Inter American University of Puerto Rico, San Juan, PR.

Poems written by 19th and 20th century poets afflicted with tuberculosis were analyzed by medical microbiology senior-level students in an effort to determine whether they gained a deeper appreciation for the scope and significance of the disease. While no lecture was given on the subject, students had to answer four questions about tuberculosis on their final examination. A pre-experience reflexive essay was written by each participating student. Students were also asked to make presentations related to each poet-poem combination, and to relate a given aspect of their disease to the poem. Fifteen students participated in the activity. One student worked by himself, while the remaining students were paired on a voluntary basis. Each pair drew the title of their assigned poem. After students had completed the analysis of the poem and made their respective presentations, and right after their final examinations, they were asked to complete a questionnaire and to write a second reflexive essay. While only 21.4% of the students answered correctly a question regarding secondary or reinfection tuberculosis, 60-100% answered correctly questions related to disease transmission, origin of the organism and physiological characteristics of the etiologic agent. For the first reflexive essay, students mentioned predominantly 20 terms or concepts, versus 13 for the second reflexive essay. A larger dispersion of terms was observed for the former. The questionnaire related the students’ change of attitude regarding the impact of tuberculosis on individuals. Students agreed more strongly with statements regarding how they liked the poem assigned to them, how it made them think about the poet’s feelings and state of mind, about the global health significance of tuberculosis and about how reading the poem modified their opinion about the significance of tuberculosis for individuals.

Microbial Cultures Coupled with Digital Data Collection, Narratives and Animations: Can these Activities Improve Students’ Understanding of Cellular Respiration?

J. Reuter1, J. Wandersee1 and J.W. Bennett2.
1Louisiana State University, Baton Rouge, LA, 2Tulane University, New Orleans, LA.

This research developed three types of animated learning activities with Kimchee, leavened bread, yogurt, and soil cultures to improve understanding of difficult cellular respiration concepts. The three types of innovative activities were: animated concept presentations and narratives, digital data collection with sensors (e.g. using CO2 sensors to determine the rate of CO2 production), and student-constructed animations. The participants were 24 undergraduates enrolled in an introductory-level biology course at a major research university, which were divided into two groups. The Comparison Group received traditional instructional and laboratory activities, whereas the Experimental Group received animated learning activities. The data collected included student-constructed concept maps and interviews about the learning activities. Concept maps were scored by assigning points to each biochemically correct component of the map. The interview transcripts were analyzed with the constant comparative method, which coded the text to reveal categories, comparisons, and patterns in the verbal data. The Experimental Group’s concept map results indicated a 39% increase in understanding of cellular respiration upon completion of instruction and no decrease over two-weeks. The Comparison Group increased by only 4% with equivalent time on task and a decrease over two weeks. Interviews revealed the following student conclusions about learning with the animated activities. The animations helped students remember concepts due to the applications. Layered animations introduced concepts individually to prevent confusion from thinking about many unfamiliar concepts simultaneously and helped the students to organize the concepts from general to specific concepts and recall. Digital data collection immediately displayed data and allowed for reflection and discussion of the concepts which increased understanding. Student-constructed animated presentations allowed them to apply concepts to daily life and to improve their organization of knowledge from general to specific, which helped them to remember the concepts.
51-C

Integrating Concepts in Lecture Class Using Case Studies

# P. Franklin. Piedmont Virginia Community College, Charlottesville, VA.

Allied health students, particularly in Nursing, find it a challenge to apply difficult microbiology concepts to their everyday lives and career choices. This project uses a case-study approach to facilitate the comprehension of core microbiology concepts in a General Microbiology class.

The project employs a combined strategy to integrate conceptual understanding and contextual relevance: i) concept maps were developed to provide a framework for the integration of microbial taxonomy, metabolism and genetics; ii) case study rubrics were created in alignment with learning goals and assessment of conceptual understanding. The learning process was scaffolded using case study analysis, whereby case studies were introduced with questions designed to promote reflection and discussion. Students were encouraged to develop their own questions, though their questions were initially primarily focused on content. Individual and team responses to written questions and participation in classroom or online discussions were analyzed.

To further refine this approach, I created a rubric for an integrative case study selected from the National Center for Case Study Teaching in Science. Conceptual integration was reinforced through the combination of lectures, quizzes, teamwork, and face-to-face and online discussions centered on the case study. The co-emergence of intrinsic motivation and increased conceptual understanding was evidenced by increased student participation and engagement, improved performance in exams and essays, and peer learning and teaching. To track conceptual learning a case study instrument was developed that analyzed: team answers to questions and progressive active participation in discussions. Student feedback was acquired from: i) team comments on the case study as an instructional tool; and ii) open-ended final exam questions (distributed to students prior to the exam) on the relevance of case study use to their everyday life and career choices. The case study analysis and student feedback will inform modifications and improvements on this project. A long term goal is for other Microbiology faculty who teach similar courses to use and evaluate the case study tool in their classes.
Using Clickers in the Classroom to Strengthen 'Just in Time Teaching'
R.A. Gyure. Western Connecticut State University, Danbury, CT.

The use of personal response systems ('clickers') has greatly increased over the past few years and is particularly useful in the instruction of large enrollment courses. These devices have been shown to increase student interest in subject matter, encourage critical thinking, and stimulate peer interaction and class discussion. Another teaching and learning strategy called 'Just in Time Teaching,' (JiTT) was originally conceived to combine web-based study assignments and an active learner classroom. Students respond electronically to carefully constructed web-based assignments which are due shortly before class, and the instructor reads the student submissions “just-in-time” to adjust the classroom lesson to suit the students’ needs (see webphysics.iupui.edu/jitt/jitt.htm). Since its inception, JiTT has also been modified by some to include non web-based assignments to encourage students to prepare and think about course material before attending class. In this study, I used clickers for the first time in my large-enrollment allied-health microbiology course and combined this with a JiTT curriculum. A main goal was to use the clickers to reward students and provide feedback on their JiTT study assignments, although the clickers were used in other ways such as engaging students in discussion about current events related to microbiology and revealing misconceptions and weaknesses in their understanding of course material. By administering an attitudinal survey during the first half of the semester and comparing it to the same survey done at the end of the course, I learned that students a) had continued anxiety about use of clickers as long as responses were graded; b) generally agreed that the graded questions provided a strong stimulus for course preparation (JiTT); and c) understood the pedagogical value of clicker use. Based upon my experience with this approach in the classroom, I highly recommend it and will continue to refine and utilize it in my large-enrollment courses.

The MicrobeLibrary Website: What’s In It For You?
E.L. Suchman1 and A. Chang2. 1Colorado State University, Fort Collins, CO and 2American Society for Microbiology, Washington, DC.

In 1997, MicrobeLibrary (ML) founders envisioned, “The proposed library is analogous to an electronic journal of peer-reviewed scientific articles for the research community. The ML will be an electronic journal of peer-reviewed educational resources for the teaching community.” Nearly ten years later, with support from the NSF, the ML website has joined the AAAS’s Bioscience Education Network (BEN). All resources, peer reviewed for scientific accuracy and instructional value, promote ASM’s curriculum recommendations. The acceptance rate for visual, curriculum resource submissions and education research journal articles is 70%, 55% and 40% respectively. There are over 1400 learning objects contributed by scientists worldwide. Thirty percent of resources within the ML are visual resources; 37% are science and education feature articles and journal papers; 29% are reviews of books, videos, software, and websites; and 5% are curriculum resources. In 2004, the average number of monthly visitors was 17,085 conducting 2,283 searches. In a 2003 survey, 55% of ML users cited Visual Resources and 32% cited Curriculum Resources as most valuable. On-line subscriptions are required for all ML collections except the visual resources. Surveys of ASM members indicate that more materials, especially in the Visual Resources collection, are desired. In response to this, ASM MicrobeLibrary committee members conducted a gap analysis to identify the critical content gaps. The committee and staff are now working to increase the inventory of the Visual Resources by actively recruiting authors to submit needed images, especially in the areas of virology, microbial cell biology, microbial genetics, and environmental microbiology. An additional area of current focus in the MicrobeLibrary is attitudes and perceptions regarding digital publication of scientific and scholarly materials. By constantly analyzing data and taking into account user and contributor needs, the MicrobeLibrary has become a valuable database of peer-reviewed educational microbiology resources available electronically to microbiologists and virologists worldwide.
54-C

Using Writing as a Tool to Improve Student Learning: What Does the Process of Learning Look Like?

#L.B. Taras, Kingsborough Community College, CUNY, Brooklyn, NY.

Writing has been considered by some more than a means of communicating, but an instrument for learning, thinking and developing ideas. "Writing to learn" was studied in a microbiology course for allied health students. Prior to each exam, students in one microbiology class, designated a writing intensive (WI) section, were given essay questions on the major topics for the exam. Students completed the questions, brought them to class, and worked in groups to comment on and score one another’s answers. These “think aloud” sessions were videotaped in order to study the process by which students go about answering the essay questions and solving problems. After the “think alouds”, students were given the opportunity to change their answers and resubmit them to the instructor. Corrected answers were returned to the students prior to the exam. Results on the multiple choice questions and the essay questions in the WI section were compared to those of a nonWI section. Analysis of these results seems to indicate no difference in student performance between the two sections. Responses to student surveys and an analysis of the videotaped “think aloud” sessions demonstrate a change in student’s perception of how they learn and the processes utilized in learning.

55-A

Astrobiology: Workshops and Websites for Educators

M. Bahr and S. Bordenstein. The Marine Biological Laboratory, Woods Hole, MA.

The mission of the NASA Astrobiology Institute is to study the origin, evolution and future of life in the universe. The MBL Astrobiology team explores the evolution and interaction of genomes of diverse organisms that play significant roles in environmental biology over evolutionary time scales. Communication about our research includes the personal contact of teacher workshops, and the development of web-based resources. The "Discover the Microbial World Within!" workshop focuses on a widespread group of intracellular bacteria, Wolbachia. Wolbachia occurs in up to 75% of all insect species and its spread represents one of the great pandemics of life on this planet. In cooperation with the National Science Foundation program, Frontiers in Integrative Biological Research, we developed a set of integrated laboratory exercises that uses Wolbachia to teach both microbial and insect biodiversity for the high school or undergraduate classroom. Topics cover insect collection, the mutualistic and parasitic bacteria that live within them, DNA extraction, and simple molecular biology and evolutionary analysis skills. Emphasis is on activities and experimental systems that can be used easily in the classroom to teach basic biological principles. On the web, micro*scope (http://microscope.mbl.edu) has images of microbes, classification schemes, descriptions of organisms, talks and other educational resources to improve awareness of the biodiversity of our microbial partners. Microbial Life Educational Resources (MLER, http://serc.carleton.edu/microbelife/index.html) provides an expanding resource about the ecology, diversity and evolution of microorganisms for students, K-12 teachers, university faculty, and the general public. MLER includes websites, PowerPoint presentations, teaching activities, data sets, and other useful materials for creating or enhancing courses related to microbiology.
Use of a Multi-Player Educational Digital Game for Undergraduate Medical Microbiology

J. Gnarpe¹, B. Bray² and B. Boufford².¹
Department of Medical Microbiology and Immunology and ² Academic Information and Communication Technologies (AICT), E-Learning Group, University of Alberta, Edmonton, AL, Canada.

A new digital multi-player educational game was adapted as a study aid and learning tool in a large undergraduate medical microbiology course. This asynchronous game was linked through an E-learning platform used in the course (WebCT Vista) to supplement conventional lectures. Students chose an alias and retained it throughout the three-month course term. Multiple choice questions of five levels of difficulty were loaded into the game template and students chose the game level at which they wished to play – the lowest level was the “bottle washer” and the highest “microbe slayer”. Points were accumulated by correctly answering the multiple-choice questions; an incorrect answer resulted in the subtraction of an equal number of points for each question. At specified levels of points, students could upgrade their “strength” by buying “immune cells”, an “increased mutation rate” or an “increased level of virulence”. Subsequent points could be earned by re-taking the quiz or by attacking other players from a pull down list. If the attacker was stronger than the defender the attacker could win some points from his/her opponent. The asynchronous format of the game allowed to students to fit the activity to their schedule instead of adapting their schedule to meet in a real time (synchronous) activity. The competition inherent in the game proved to be a powerfully motivating activity for the majority of students who were players. Feedback from the students indicated that this was a superior learning tool and study aid: the questions reappeared in a random fashion and the next time they appeared the students had learned the correct response. This was an excellent method by which students could, while enjoying the activity, review their course material and prepare for exams.

Using a Bioterrorism Simulation to Improve Select Agent Identification

* T.T. Meilander, S.L. Helfinstine and C.J. Woolverton. Center for Public Health Preparedness and Department of Biological Sciences, Kent State University, Kent, OH.

The 2001 anthrax attacks in the US reinforced the concern of bioterrorism vulnerability. While traditional first responders prepare for the next hazardous events, laboratorians need to prepare as well. Here we present a novel teaching simulation that conforms to the CDC rule out procedures for sentinel laboratory personnel. The simulation is designed to run on CD-ROM or remotely through the internet. Features of the simulation include realistic case studies and descriptions, images of (1) Gram stained organisms (2) colonial morphology, and (3) results of biochemical reactions. After selecting a case study, students evaluate the relevant data so as to identify the causative agent. Feedback regarding the correctness of the identification is provided. After completing the simulation, students should understand the processes by which bacterial select agents are identified, the theory behind various microbiological tests used to identify bacterial agents, and principles and practices used to identify select agents. The simulation automatically collects user assessment data for analysis. Our preliminary evaluation of assessment data suggest that the simulation is well received and meets the stated learning objectives. Anecdotal data indicate that the simulation is fun, informative, well-made and accurate. Users report an increased knowledge base and increased recall of specific techniques used to rule out select agents. This work was supported by CDC Cooperative Agreement U90/CCU524197-01.
58-A
A How-To-Guide to Publishing in the ASM MicrobeLibrary’s Curriculum Collection
J.A. Cardinale. Alfred University, Alfred, NY.

ASM MicrobeLibrary’s Curriculum Collection features field tested peer-reviewed activities promoting active learning in undergraduate microbiology. The classroom activities and laboratory exercises were developed by faculty at diverse institutions and include inquiry-based field-tested materials, student-driven activities, case-based problems, and ideas for independent and/or research projects. The Curriculum Collection, however, is not only a compilation of high quality activities for use in an undergraduate course, but is analogous to an electronic peer-reviewed journal for publication of scholarly articles related to teaching pedagogy. Publication in MicrobeLibrary’s Curriculum Collection allows recognition of an individual’s scholarly work and an opportunity to share effective exercises with a community of microbiology educators. This poster will lead you through the submission process, from preparation of the activity (including formatting and support materials required) to testing the activity in a classroom or laboratory environment. Suggestions for assessment are given, along with guidelines for developing complete and separate student and instructor versions of the exercise. Common problems among submissions which are not accepted are presented, along with examples from effective submissions. Finally, we hope through an understanding of the review and acceptance criteria utilized by the editorial board, a greater number of microbiology educators will develop and submit their innovative activities to the MicrobeLibrary’s Curriculum Collection.

59-B
Research as a Tool in Undergraduate Education
M.G. Watve, Abasaheb Garware College, Pune, India.

A common perception of the relationship between education and research is that Bachelor and Master’s level education is a prerequisite for research. We experimented on using research as a tool in education from the first year of bachelor’s degree to the end of the Master’s program. Participation was voluntary and there was no formal procedure or screening of students for participation in the program. The duration of the projects varied from six months to four years and the entry and exit options were kept open. Research projects originating from students’ own ideas were encouraged and given top priority. An open discussion forum was often the source of new concepts and themes. This led to research projects in a wide diversity of areas ranging from bacterial genetics to human behavior. In terms of tools the different projects covered lab work, field work, questionnaire surveys or computer simulations. Between 1994 and 2005 over 100 students participated in research projects out of which 61 ended up publishing papers in refereed journals, patenting or presenting in national or international conferences. Some of the studies made pioneering contributions to new concepts or fields of science that were later picked up by professional researchers. A follow-up study of these students revealed that 32 out of the 50 feedbacks received had taken up a research career following their degree courses. Majority opined that a research experience during undergraduate education was critical in deciding their career choice. This model of undergraduate research differs from conventional summer training and summer research projects in that this was a non-time-bound ongoing program, where students were given the freedom to explore their own ideas rather than participating in an established research program. The model has a high risk tolerance since it is not related to credits or grades and therefore facilitates work on novel ideas. Three major successes of the program were (i) pioneering novel concepts in science (ii) attracting and motivating students to take up research careers and (iii) inculcating research aptitude and qualities.
Using MicrobeLibrary to Visualize the Microbial World! How Visual Resources Will Change How You Teach!

A.C. Smith. University of Maryland College Park, College Park, MD.

MicrobeLibrary, established in 1998 contains two free peer-reviewed resources that offer images for microbiology educators who teach at the undergraduate level: The Visual Collection and the Atlas Collection. As of January 2006, there were 420 visual resources in the MicrobeLibrary. Still images make up around 60% of the collection. The remaining 40% include animations and video clips. The Atlas/Protocol Collection was established from conversations at the 2004 ASMCUE meeting. In 2005, 139 images were added to MicrobeLibrary through this new resource. Peer reviewed at the ASMCUE 2005 meeting the four A/P projects are: the Blood Agar Plate, the Gram Stain, the MacConkey Agar Plate, the Serial Dilution and the Triple Sugar Iron Agar. The Atlas collection lies in the visual resources area while the Protocol collection is within the subscription based Curriculum collection. The protocols offer historical, theoretical and technical information. The Atlas/Protocol collections are prepared by project managers, but the wider community of Microbiology Educators have contributed to this resource by supplying images, by contributing comments and tips to the protocols, or by serving in the peer review session at ASMCUE. Six new projects will be added this year. In 2004 a survey was done on the BEN portal which allows access to ML. 25% of the 515 respondents indicated that they accessed the ML resource. 67% of respondents indicated they were looking for resources for lecture, 35% were looking for non-lecture resources, Our goal is to encourage more undergraduate educators to use and submit images to ML. This poster will highlight examples of how individuals have used visual resources.

Examples include: supplementing lecture power point presentations on microbial morphology, microbial diversity and pathogenesis, adding images to case studies, using images in problem based and inquiry learning, posting images to course online sites to allow for review of lab work or for quizzing on standard lab technique, use of images in lab exams to test data analysis, images as resources for student projects, and the use of animations to highlight concepts in lecture or protocols in lab.

Adding Podcasting and Streaming of PowerPoint Lectures to an Online Microbiology Course – Is it an Effective Learning Modality for Online Students and Helpful as a Supplement for Traditional Students?

R. Alisauskas. County College of Morris, Randolph, NJ.

Students enrolling in this Hybrid Microbiology Course have all of their lectures delivered online via WebCT using streaming media and podcasting of audio. My goal was to provide students who could not attend in-person classes with a similar learning experience as traditional students and to provide in-person students with non-traditional learning modalities. Student survey data will be shown demonstrating ease of access, convenience, and student perceptions on their connectedness to the faculty member, connectedness to their fellow students, and ability to learn the material.

The survey will attempt to determine the difference in the number and types of learning modalities used by online students versus face-to-face students in the same course. This will be correlated to outcomes such as grade averages of each group of students and their engagement with the course materials as determined by analysis of student tracking data.

This poster will detail methods and materials for transforming your in-person PowerPoint lectures to a format suitable for web delivery. The lectures, as they were presented in the classroom, are available to both groups of students for viewing and listening anytime, anywhere. PowerPoint Lectures with audio are captured, rendered out into a video format that is suitable for both streaming from a windows media server and converted to an mp3 audio file using an audio conversion program. The video file is uploaded to a streaming server. The mp3 files are uploaded to an open server. Students view the streaming video by clicking on a link in their WebCT course. The students receive the podcasts after they subscribe to a RSS link in their podcatcher software.

This delivery method is enthusiastically accepted by some students while others cautiously approach and adopt only after peer tutoring. Although the materials were available to all students, the extent and desire of in-person, traditional students to take advantage of these course supplements differ as does the leaning outcomes. Typically, exam averages are higher with the group of online students.
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2005-2006 ASM SCHOLARS
ASM welcomed the inaugural class of the ASM Scholars-in-Residence Program in 2005. Below is a list of those who attended the ASM SoTL Summer Workshop, July 27-30, 2005 and will complete their residency at ASMCUE 2006.

Michael D. Boyle  
Juniata College

Mary Teresa Brandon  
New Mexico State University/Dona Ana Branch Community College

Cynthia L Cooper  
Truman State University

Patricia Franklin  
Piedmont Virginia Community College

William R. Huddleston  
University of Calgary

Kathleen S. Jagger  
Transylvania University

Carmen A. Oquendo  
Inter American University of Puerto Rico, Metropolitan Campus

Marcy A. Peteroy-Kelly  
Pace University

Laura B. Regassa  
Georgia Southern University

Laurel Roberts  
University of Pittsburgh

Michele Shuster  
New Mexico State University

Stephanie S. Strand  
Washington University

Loretta B. Taras  
Kingsborough Community College of the City University of New York

Pamela A. Tranby  
Riverland Community College

Laura Tuhela-Reuning  
Ohio Wesleyan University

Dara L Wegman-Geedey  
Augustana College

2006-2007 ASM SCHOLARS
The 06-07 class of Scholars has been selected. Scholars will begin their year-long residency at the ASM SoTL Summer Workshop, July 26-29, 2006.

Susan Godfrey  
University of Pittsburgh, Pittsburgh, PA;

Ruth Gyure  
Western Connecticut State University

Rodney Hagley  
University of North Carolina

Shazia Hakim  
Jinnah University for Women, Karachi, Pakistan

Lee Hughes  
University of North Texas, Denton

Ruhul Kuddus  
Utah Valley State College, Orem

Gary Kuleck  
Loyola Marymount University, Los Angeles, CA

Jennifer Leavey  
Georgia Institute of Technology

Liiliana Losada  
Trinity University

Clifford Renk  
Florida Gulf Coast University

Kristy Shanahan  
Oakton Community College

Joyce Shaw  
Endicott College

Jason Tor  
Hampshire College

Fredric Volkert  
SUNY - Downstate Medical Center
Fellowships
(Sponsored by The Education Board)

POSTDOCTORAL

ASM/NCID Postdoctoral Research Fellowship
Encourages postdoctoral scientists to conduct research in infectious diseases, medical microbiology and immunology at the National Center for Infectious Diseases. The fellowship is for two years.
Deadline: January 15
Web Address: [Website Link]

GRADUATE

Robert D. Watkins Graduate Research Fellowship
Encourages graduate students from underrepresented groups to conduct research in microbiological sciences. The fellowship is for three years.
Deadline: May 1
Web Address: [Website Link]

UNDERGRADUATE

ASM Undergraduate Research Fellowship (URF)
Encourages undergraduate students to conduct a research project in the laboratories of ASM members at their home institution for a minimum of ten weeks and, to present the research findings at the ASM General Meeting.
Deadline: February 1
Web Address: [Website Link]

Microbiology Undergraduate Research Fellowship (MURF)
Encourages undergraduate students from underrepresented groups to conduct a research project in the laboratories of ASM members at their home institution or at a host institution, for a minimum of ten weeks and, to present the research findings at the ASM General Meeting and the Annual Biomedical Research Conference for Minority Students (ABRCMS).
Deadline: February 1
Web Address: [Website Link]