19th Annual ASM Conference for Undergraduate Educators (ASMCUE)

San Mateo Marriott
San Mateo, California
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ANNUAL CONFERENCE ABSTRACTS
Poster Presentations – Saturday, June 16, 2012

Session A
Author Presentations: 9:15 AM – 10:15 AM

Session B
Author Presentations: 1:30 PM – 2:30 PM

ALIGNING ASMCUE ABSTRACTS TO BIOLOGICAL CONCEPTS

The 2012 abstracts are organized by both content and pedagogy to help participants navigate more easily through the poster session. The content themes are organized by six core concepts. Five of the concepts were put forth in the 2011 national report, Vision and Change in Undergraduate Biology Education: A Call to Action and include evolution, structure and function, pathways, information flow, and systems. A sixth concept specific to microbiology, the impact of microorganisms, is also used. The complete guidelines may be found at www.asm.org/educators under Curriculum Resources. The pedagogy themes are organized into five categories: course design, hands-on projects, student learning, teaching approaches, and teaching tools. Each abstract is assigned to both content and pedagogy themes. These assignments, designated by the submitting author, are placed below the full abstract. A quick reference index listing abstracts by content, pedagogy, and author is available at the end of the abstract section.

1-A
Perspectives in Microbiology: Using Video-Based Assignments to Enhance Students’ Historical and Global Understanding of Infectious Diseases
Missouri Western State University, St. Joseph, MO.

2-B
The Use of an Interactive In-classroom Tool to Improve Student Performance on Knowledge Acquisition and Application
E.L. Blewett1, B.J Reddig1, and J.L. Kisamore2.
1Oklahoma State University, Tulsa, OK and 2University of Oklahoma – Tulsa, Tulsa, OK.

3-A
Active Learning and Advising Strategies in Freshman Introductory Biology—If You Build It, Some Will Come
S.B. Boomer, K.L. Latham, and M.J. Baltzley.
Western Oregon University, Monmouth, OR.

4-B
A Research-based Introductory Biology Laboratory Course Positively Impacts Student Attitudes Towards Research: Results of a Two-Year Comparison Evaluation
Stanford University, Stanford, CA.

5-A
Calibrated Peer Review Use Improved Low-Achieving Student Performance on the California Critical Thinking Skills Test Posttest
J.P. Caruso.
Florida Atlantic University, Boca Raton, FL.

6-B
Increasing Students’ Graphicacy Using In-class Exercises
L.F. Caslake.
Lafayette College, Easton, PA.
7-A  
Role of Worksheets and Classroom Exercises in Developing Higher Order Cognitive Skills (HOCS)  
L. Chilukuri.  
University of California San Diego, San Diego, CA.

8-B  
Impact of a Student-Centered Curriculum on Performance and Self-Assessment Accuracy Across Different Levels of Cognition  
L. Clement and M. F. Wong.  
City College of San Francisco, San Francisco, CA.

9-A  
Research Based Metagenomic Soil Analysis Laboratory  
P.C. Cummings and K. M. Obom.  
Johns Hopkins University, Baltimore, MD.

10-B  
Using primary literature to increase scientific literacy in community college students  
L. DiGirolamo.  
City College of San Francisco, San Francisco, CA.

11-A  
Exploring Your Genome: Can an Introductory-Level, Online Course Increase Genomics Knowledge and Literacy?  
J.C. Drew, S. Galindo-Gonzalez, and E.W. Triplett.  
University of Florida, Gainesville, FL.

12-B  
Using Parvovirus B19 to Introduce Students to Bioinformatics and to Reinforce Molecular Biology Knowledge  
K.E. Dye.  
Mount Saint Mary’s University, Emmitsburg, MD.

13-A  
Evaluation of Cooperative Quizzes in a Team-Based Learning Course  
S.L. Elliott.  
St. Mary’s College of Maryland, St. Mary’s City, MD.

14-B  
Individualized Active Learning: Use of the Escherichia coli Model Organism Database EcoCyc in an Undergraduate General Microbiology Course  
University of California, Los Angeles, CA.

15-A  
Assessing the Impact of Metacognition and Reading Lessons on Metacognitive Awareness and Reading Comprehension in Introductory Biology  
South Dakota State University, Brookings, SD.

16-B  
Case Studies + Instant Feedback: Targeting Persistent Student Misconceptions in Biology  
A.-M. Hoskinson.  
University of Colorado — Boulder, Boulder, CO.

17-A  
What Happens When Students Develop and Answer Their Own Questions in Biology Instead of Answering Our Questions?  
J.J. Huang.  
F.W. Olin College of Engineering, Needham, MA.

18-B  
Extreme Course Redesign: Applying Scientific Teaching and the ASM 2011 Draft Curriculum Guidelines to a General Microbiology Course  
L.E. Hughes.  
University of North Texas, Denton, TX.

19-A  
Using Antibiotic-Resistant Bacteria as a Vehicle for Increasing Student Biomedical/Environmental Health Career Awareness and Appreciation for the Adaptability of the Microbial World  
C.H. Hunnes.  
Rocky Mountain College, Billings, MT.

20-B  
Mining The Immune Epitope Database (IEDB): a Novel Approach to Learn about Infectious Diseases  
H. Makhluf.  
National University, La Jolla, CA.

21-A  
Creation of a Scholars Program to Breathe Life Back into the STEM Disciplines at a Small College  
B.S. Mauck.  
College of Saint Mary, Omaha, NE.

22-B  
Learning “As” Scientists and “From” Scientists: Exploring Scientific Concepts Through Distance Learning  
M.V. Mawn.  
SUNY Empire State College, Saratoga Springs, NY.

23-A  
Does the Use of Interactive Exercises Using Three-Dimensional Models of DNA in an Undergraduate Microbiology Class Enhance Learning of DNA Concepts?  
A.H. McDonald.  
Concordia University Wisconsin, Mequon, WI.
In our allied health microbiology course, we developed a series of assignments to accomplish the following goals:
1) Expose students to historically and globally relevant issues of infectious diseases using video-based media; 2) Facilitate the use of credible web-based resources to learn about the current state of infectious diseases; and 3) Promote content learning through videos. We used three documentary- or lecture-style videos containing personal interviews and stories to expose students to content and first-hand perspectives on infectious disease topics. Students were required to view the videos, either in-class or online, answer questions about content, and work out-of-class to complete assignments that directed them to credible Web sources such as World Health Organization (WHO) and Centers for Disease Control and Prevention (CDC). A 16-question student response survey shows that with statements regarding an increase in knowledge and perspective associated with viewing the videos, 88.4% to 98.5% of respondents agreed or strongly agreed. Ninety to ninety-four percent of students agreed or strongly agreed with statements that completing the web-based assignments made them more aware of the current issues associated with the infectious diseases. Ninety-four percent agreed these videos and assignments provided a historical and global perspective beyond that achievable by
classroom lecture alone. Ninety-one percent of students self-reported they are now aware of the resources on infectious diseases available from these credible web-based resources (CDC and WHO). The mean score on a knowledge-based pretest was 46.8%, while the mean score after the assignments was 88.8%. These data lead us to conclude that video-based infectious disease assignments can be used to enhance students' historical and global perspectives, increase students' self-reported familiarity with available Internet resources such as CDC and WHO websites, and facilitate knowledge gain.

**ASM Curriculum Guideline Concept(s):** Impact of microorganisms

**Pedagogical Category(ies):** Teaching approaches

### 2-B

**The Use of an Interactive In-Classroom Tool to Improve Student Performance on Knowledge Acquisition and Application**

E.L. Blewett¹, B.J. Reddig¹, and J.L. Kisamore². ¹Oklahoma State University, Tulsa, OK and ²University of Oklahoma – Tulsa, Tulsa, OK.

Students in the Biomedical Sciences or Medical Programs at OSU-CHS must purchase and use an audience response device. This allows real-time assessment and interaction between instructors and students. Typically an instructor places a question on the display with possible answers and tracks the students’ responses. Because the results are available immediately, the instructor can reinforce key ideas and address any misconceptions. While student acceptance and use of this device is high, it remains unclear whether use of the device in class improves educational outcomes. For this study, we examined student use of the audience response system during class, and subsequent performance on corresponding exam questions for students enrolled in Medical Microbiology during the Spring 2012 semester (N = 101). In order to test the relationship between system use and exam performance, we matched questions administered via the audience response system during class time with exam questions in terms of both topic of focus (e.g., Hepatitis B serology) and question complexity (i.e., simple knowledge acquisition versus complex application). A total of 17 question pairs were identified, with 5 representing simple knowledge acquisition and the remaining 12 assessing complex application. While questions in the question pairs did correspond in topic and question type, the questions themselves were not identical. Results of the evaluation suggest that use of the device was significantly positively correlated with student performance on the exam, both simple knowledge acquisition questions ($r = 0.381$, $p < 0.001$) and to a lesser extent complex application problems ($r = 0.271$, $p < 0.01$). Overall, results of the current study suggest that the interactive system is a valid predictor of exam performance. Due to the correlational nature of the design, however, causal conclusions cannot be drawn to indicate use of the system is the cause of improved performance. Other factors such as student attendance or level of conscientiousness may account for the relationships noted.

**ASM Curriculum Guideline Concept(s):** Impact of microorganisms

**Pedagogical Category(ies):** Teaching approaches, Teaching tools

### 3-A

**Active Learning and Advising Strategies in Freshman Introductory Biology—If You Build It, Some Will Come**

S.B. Boomer, K.L. Latham, and M.J. Baltzley. Western Oregon University, Monmouth, OR.

Since 2009, our instruction team has performed assessment (background, content, and attitudinal) in Biology 211, the first course in our year-long majors introductory series covering molecules/cells, metabolism, genetics, and gene expression. In 2009, this course was four credits (3 hours lecture, 3 hours lab per week) and our performance and retention rate was poor (16% of students received Ds, 18% Fs, 14% dropped out). In 2010, our department overhauled this series, adding another weekly hour of lecture. The Biology 211 instruction team focused most of this additional hour to active learning approaches, hypothesizing that these experiences would increase student performance as measured by exam scores, content assessment, and final grades. We found that active learning made no significant difference in exam scores or content assessment scores across years (exams: ANOVA, $p = 0.73$; assessment: ANOVA, $p = 0.40$). However, active learning did have a significant effect on grade distributions (contingency table, Chi Square $0.05, 4 = 12.722, p < 0.025$), increasing the proportion of A and B students by 16.8%. We will further describe specific active learning approaches and curriculum development in our presentation, as well as favorable student attitudinal responses regarding their effectiveness. In addition to active learning, we also introduced new early advising strategies based on pre-course surveys, which will be further described in our presentation. We hypothesized that these measures would decrease the number of students receiving Fs or dropping out. However, preliminary analysis suggests that early advising did not reduce the failure or drop-out rate (contingency table, Chi Square $0.05, 6 = 9.253, p > 0.10$). Lastly, we observed no significant difference between cohorts in terms of gender, ESL status, year in college, and career interest, but the proportion of first-generation students increased in 2011 (contingency table, Chi Square $0.05, 2 = 6.676, p < 0.05$). Consequently, we are further analyzing our data to test
Recent national reports have emphasized the positive impact that a research-based curriculum can have on undergraduate biology laboratories. However, comparison groups are infrequently used in assessing the effectiveness of these research-based lab curricula, limiting the conclusions that can be drawn from these studies. We addressed this issue by implementing a newly developed research-based undergraduate laboratory course at a research-intensive institution, and comparing students enrolled in this research-based course to students enrolled in a traditional “cookbook” lab course. This research-based introductory ecology-based laboratory course has many of the hallmarks of authentic research. External assessment of students in this new course compared to students in an existing traditional “cookbook” course was conducted using a mixed methods approach of pre- and post-course surveys and observations. The first-year assessment using a matched-pair design comparing volunteers in the new course with matched students in the traditional course revealed that the new course had a significant positive effect on student attitudes regarding authentic research practices, student perceptions of their ability to do lab-related tasks, and student interest in pursuing future research. The second-year assessment using a randomized study design showed that the new course compared to the cookbook course had a significant positive effect on student attitudes regarding authentic research practices, but there were no differences in either student perceptions of their ability to do lab-related tasks or student interest in pursuing future research. Our results demonstrate that this newly developed research-based undergraduate biology lab course was successful in addressing many of the hallmarks of authentic research. However, using a randomized study design, we found fewer positive results than when we used a matched-pair study design, highlighting the importance of using comparison populations of students when determining the effectiveness of new curricula.

**ASM Curriculum Guideline Concept(s):** Information flow, Systems

**Pedagogical Category(ies):** Course design

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Calibrated Peer Review (CPR), a widely used “write to learn” method is known to raise grades ~ 10%. CPR cycles have three phases. First, students are assigned a word-limited essay and take a CPR tutorial. They then score three essays on the topic (one excellent, one average and one poor) using an instructor-designed rubric. After this, they’re given three anonymous essays to score and last must score their own, all using the same rubric. Software calculates all grades. The author wrote five CPR cycles in Spring 2011, including one on Functional Genomics for Biotechnology and one each in General Microbiology (GenMicro) Lecture and Lab. The CA Critical Thinking Skills Test (CCTST) is given as a pretest and a posttest before and after classes. Scores assessing seven different Critical Thinking areas (Inductive & Deductive Reasoning, Analysis, Inference, Evaluation, Interpretation and Explanation) are combined to give a Total critical thinking score, compared to average US four-year college students. To examine CPR learning effects, the CA CTST was given in Spring 2011 to three advanced Biology classes: GenMicro, Biotechnology, and Biology of Cancer (no CPR). The study hypothesis was CPR use would improve critical thinking skills. Over 120 GenMicro, 10 Biotechnology, and 21 Biology of Cancer students took both pre- and post-tests; > 52% (GenMicro) and 60% (Biotechnology) students improved posttest scores, whereas ~ 43% of Biology of Cancer students improved posttest scores. Results neared significance (0.05 < p < 0.10) by ANOVA and ANCOVA. Nearly 80% of low-achieving students (< 25th percentile) took the posttest; GenMicro students were ~ 75% of these. This sub-group is the most at-risk for failing STEM courses at minority-serving schools like FAU. Just 35% of these students increased posttest scores > 6 percentile points and exceeded the 25th percentile; all but one of these were GenMicro students, almost all of whom took both CPR cycles. When these observed vs. expected results were tested by the Binomial Test, a p = 0.031 was seen. These results show CPR may increase STEM retention among at-risk students at a heavily minority-serving public university.

**ASM Curriculum Guideline Concept(s):** Impact of microorganisms

**Pedagogical Category(ies):** Student learning

**6-B**

**Increasing Students’ Graphicacy Using In-Class Exercises**

L.F. Caslake. Lafayette College, Easton, PA.

Graphicacy, the ability to create, interpret, and critically evaluate descriptions and representations of scientific
data including graphs, tables, and models is an important program-level outcome for biology majors at Lafayette College. Our baseline assessment data, taken at the end of our one-year general biology sequence, indicates that students do not come to college with these skills. Asked to answer questions based on a scientific poster at the end of General Biology, over 90% of first-year Science majors could identify test and control conditions, but only 50% could successfully identify dependent and independent variables, and only 42% could summarize the central finding of the poster. Non-Science majors fared much worse. I hypothesized that participating in repeated, authentic graphing exercises would improve students' ability to read graphs and tables. Students enrolled in Molecular Genetics (n = 24) in fall 2011 were given a pretest in late October. Two discussion-based exercises (approximately three weeks apart) requiring students to interpret a figure from a published paper were completed in class. The posttest was embedded in the final exam. The pretest and in-class exercises were from the same published article; the posttest figure was from a related article. On the pretest, 83% of students successfully identified the dependent and independent variables. However, only 40% were able to correctly interpret the survival curves and the effect on survival of a particular genetic mutation. On the posttest, 87% of students were able to identify dependent and independent variables, and 79% correctly interpreted the results presented in the figure. Molecular Genetics students were able to differentiate between dependent and independent variables and the in-class exercises had a positive impact on students' ability to decode information presented in a figure. These students were overwhelmingly seniors (n = 19) majoring in Biology and Biochemistry (n = 21).

**ASM Curriculum Guideline Concept(s): Structure and function**

**Pedagogical Category(ies): Teaching approaches**

### 7-A

**Role of Worksheets and Classroom Exercises in Developing Higher Order Cognitive Skills (HOCS)**

L. Chilukuri. University of California San Diego, San Diego, CA.

This study examines the role of worksheets and classroom exercises in improving the acquisition of HOCS as defined by Bloom's Taxonomy in our lab. The worksheets focused attention on specific concepts prior to lecture, while classroom exercises practiced their application. It is our hypothesis that both approaches increase student familiarity with, and confidence in, the concepts. BIMM 121, an upper division Microbiology laboratory course, is offered in several sections without prerequisites. All sections attend the same lectures, but receive separate exams and different worksheets. The goal of ensuring that all students acquire a strong grounding in facts and effective analytical skills is complicated by the range of student experience with microbiology and the brevity of the quarter (10 weeks). Cognitive skills are developed and practiced through the quarter by judicious use of classroom and lab exercises, lab reports, and homework assignments. Assessment of cognitive skills acquisition is through exam questions developed and ranked as HOCS questions or LOCS (Lower Order Cognitive Skills) questions using the Blooming Biology Tool. An average exam was about 60% LOCS and 40% HOCS questions. Questions associated with the worksheet were consistent across sections and across multiple quarters. Control questions were developed for topics with classroom exercises but no worksheet, as well as topics without either. Results of the study indicate that students had no difficulty with LOCS questions and fared overall better on the HOCS questions associated with classroom exercises with or without the worksheet than they did on HOCS questions on topics without either. Students appeared confident in the material when they had the relevant practice, averaging around 70% of the maximum score, indicating the efficacy of using classroom exercises and the worksheets. The limits of their cognitive skills and the relationship to the worksheets will be assessed with more challenging HOCS questions in the current quarter.

**ASM Curriculum Guideline Concept(s): Impact of microorganisms**

**Pedagogical Category(ies): Teaching approaches, Teaching tools**

### 8-B

**Impact of a Student-Centered Curriculum on Performance and Self-Assessment Accuracy Across Different Levels of Cognition**

L. Clement and M. F. Wong. City College of San Francisco, San Francisco, CA.

AAAS's *Vision and Change* recommends using scientific teaching and focusing on core biology concepts rather than factual information, especially in nonmajor science classes. A community college Biotechnology class was redesigned using a student-centered curriculum. We encouraged students to use a constructivist approach to learning, challenged their misconceptions, and assessed them regularly using opened-ended questions about new concepts. We asked whether this shift in pedagogy resulted in comparable development of cognition across Bloom's Taxonomy levels. In addition, we were interested in measuring metacognitive skills across these levels, as studies have shown that lack of metacognitive skills is one of the barriers to success for new college students. In fact, students have the most difficulty self-assessing their performance in Bloom's levels 1, 2, and 3. Therefore, students' performance and self-efficacy (n = 13) in a final exam were compared across these Bloom's levels. Although students performed significantly better in level 2...
questions over other levels (B2 vs. B1, \( p = 0.0006 \); B2 vs. B3, \( p = 0.025 \)), students’ prediction of their performance did not differ significantly between levels, indicating that students believed that they would perform as well in all types of questions. We then compared accuracy of self-efficacy across levels and showed that students were significantly more accurate in evaluating their performance for level 2 questions compared to level 1 (\( p = 0.0326 \)) and level 3 (\( p = 0.0037 \)) questions. In fact, students had a tendency to be over-confident in their abilities to answer level 1 and level 3 questions. Together, these results indicate that students seemed to be more prepared to demonstrate their understanding of a core concept than to recall factual data, and that they were more accurate in their self-assessment of this performance, a key feature of metacognition. This could be due to the use of open-ended questions as an assessment tool in this class. Our next step will be to determine if cognitive and metacognitive skills correlate with metacognitive awareness and educational level in this highly diverse population.

ASM Curriculum Guideline Concept(s): Information flow, Impact of microorganisms
Pedagogical Category(ies): Student learning

9-A
Research Based Metagenomic Soil Analysis Laboratory
P.C. Cummings and K. M. Obom, Johns Hopkins University, Baltimore, MD.

Metagenomic DNA analysis involves the isolation and sequencing of microbial genetic information from complex systems such as the natural environment or host tissues. Specific fields of study that utilize metagenomic investigations include environmental gene surveys, noncultivable microbe characterization, bacterial community metabolism, microbial evolution and ecology, and bioremediation. Using a research-based laboratory approach, we have designed a series of laboratory exercises for a semester-long course where students use the tools of molecular biology to isolate genomic DNA from soil samples, clone genomic fragments into a plasmid vector, and obtain DNA sequence information of cloned inserts to perform bioinformatics analysis using NCBI software. This study attempted to answer two questions: 1) could students do basic research in a laboratory class setting that would yield publishable results?, and 2) did this approach enhance or detract from the student learning experience? To answer the first question, students identified ten isolates that were sequenced and analyzed using BLAST programs for nucleotide sequences (blastn), protein sequences (blastp), and translated nucleotide sequences against protein database (blastx). Students also used the gene-finding program at Softberry.com to identify potential genes. Several proteins were identified using these methods including a transposase. Further characterizations including gene annotation, motif identification, and structural similarity study using PDB, were undertaken. The students were able to identify previously unknown sequences that can be entered in Genbank. A post-course survey of the students indicated that 86% of students strongly agreed with the statements: The course structure and assignments were an effective way to learn the material; I learned a great deal from the course; I would recommend the course to other students. This course design represents a model for teaching metagenomic investigations and bioinformatics analysis within the context of a research based approach.

ASM Curriculum Guideline Concept(s): Structure and function, Impact of microorganisms
Pedagogical Category(ies): Course design, Hands-on projects

10-B
Using Primary Literature to Increase Scientific Literacy in Community College Students
L. DiGirolamo. City College of San Francisco, San Francisco, CA.

Scientific literacy is considered an important goal of undergraduate education. Community colleges like City College of San Francisco (CCSF) serve a substantial number of minority, low-income, and first-generation college students. Many students begin underprepared, particularly in math. Teaching strategies need to provide quality education in content area while giving remedial aid. Starting two years ago, I began incorporating practice with examples from primary literature with the following goals: 1) increase understanding of scientific process, 2) increase active learning without sacrificing content, and 3) give students access to primary research in an accessible format. Frequent assessment activities were integrated into lectures using data from primary literature that illustrated theoretical concepts. Students formulated hypotheses, interpreted graphical representations of data from research papers, and integrated these conclusions into theory learned in class. These quick (3–5 minute) activities relate directly to concepts being studied and use authentic, current research. This study evaluates this method. Questions relating to scientific processing skills on exams were analyzed from semesters before and after implementation. Before using this method, students’ exam score gain (from last to first exam) was 5.8%; after, the increase was 62.4%. In addition, 89% of students surveyed reported they understood the process of science; only 33% agreed before. Similarly, self-reported scientific literacy increased from 19% to 74% over the semester. Before the class, 41% could successfully interpret a graph, while 100% were able to do so after; 63% could make a hypothesis from the data after the class, 8% could before. And 79% of students reported the activities helped them learn science skills and deepen their understanding of the material. In conclusion, frequent,
assessments with examples from primary literature helped
CCSF students with limited math skills improve their sci-
ence processing skills while not lessening course content. In the future, I will test if this method increases depth of understanding and retention.

ASM Curriculum Guideline Concept(s): Evolution
Pedagogical Category(ies): Student learning, Teaching tools

I1-A
Exploring Your Genome: Can an Introductory-Level, Online Course Increase Genomics Knowledge and Literacy?

Vision and Change in Undergraduate Biology Education: A Call to Action and BIO 2010, as well as other reports, emphasize the importance of promoting biological literacy in introductory-level courses. These reports also highlight the need to teach to the evolving and cutting-edge aspects of biology, such as genomics. “Exploring Your Genome” is an introductory-level, web-based course at the University of Florida. The long-range course objectives include developing genomics literacy and preparing students for the age of personal genomics. Specific course objectives are to introduce genomics, to reinforce classic genetics concepts, to use simple bioinformatic tools, to understand the role of one’s genome in disease, and to encourage scientific thinking. An assessment of the first year of the course indicated an improvement of student learning. Since the pilot effort, the course has been improved in various ways such as strengthening the links of learning objectives to materials and assessments. We hypothesized that the changes in the course would result in increased student learning and genomics literacy, and this hypothesis was tested through quantitative and qualitative methods. Anonymous pre- and postcourse questionnaires provided a comprehensive assessment of the course. The questionnaires contained a mix of objective and open-ended questions focused on knowledge gains, skill acquisition, and attitudes. Data were collected for three semesters to determine if the implemented changes improved student learning and genomics competency. Recent results demonstrate student learning as measured by knowledge gains in a pre- and posttest (pre mean = 57%; post mean = 84%; p < 0.0001). The difference between the pretest and posttest scores has gradually increased over three semesters from a 22% to a 27% increase in student learning. An overview of the NSF-funded Sequencing Gators program, course structure, and syllabus, and a full analysis of the assessment results will be presented. This work is part of an NSF-funded Course, Curriculum, and Laboratory Improvement project, and we gratefully acknowledge this support.

ASM Curriculum Guideline Concept(s): Information flow
Pedagogical Category(ies): Course design

I2-B
Using Parvovirus B19 to Introduce Students to Bioinformatics and to Reinforce Molecular Biology Knowledge
K.E. Dye. Mount Saint Mary’s University, Emmitsburg, MD.

Currently, 67% of students enrolled in Virology (n = 15) at MSMU have no prior upper-level molecular biology (MolBio) coursework (Genetics; Molecular and Cellular Biology). Consequentially, most enrolled students last studied MolBio at the end of their first college semester (two years ago), presenting a challenge to grasping viral life cycles. As such, the first 2.5 weeks of Spring 2012 (intro period) were devoted to building a MolBio foundation that would allow students to succeed in Virology. To this end, I developed a survey and MolBio assessment tool to gauge students’ perceived and actual, respectively, pre- and post-intro period MolBio knowledge. I also developed an exercise in which students explored general and MolBio characteristics of Parvovirus B19 through an introduction to online, public-access Bioinformatics tools. I hypothesized that use of this exercise, combined with traditional lecture techniques, during the intro period would increase MolBio and Bioinformatics knowledge and ability to manipulate genetic information. Perceived and actual knowledge after the intro period increased on average 24 pts (scale of 0–64) and 13 pts (scale of 0–37), respectively. Number of students with knowledge of, and ability to work with, specific Bioinformatics tools increased from 4 to 15. It is difficult to say to what degree increased MolBio knowledge was due to the Bioinformatics exercise as opposed to traditional lecture; the exercise has built-in lecture opportunities that were utilized when student responses to exercise questions revealed a need. I conclude that the combination of lecture techniques and the Bioinformatics exercise enhanced MolBio knowledge, and that the exercise itself increased knowledge of, and facility with, specific Bioinformatics tools. To cement this new knowledge, each student will complete the Bioinformatics exercise a second time during Spring 2012, using a virus of their choosing, to demonstrate learned ability to manipulate genetic information and to use Bioinformatics to investigate individual viruses. The results of this second exercise will be obtained and analyzed by the end of April 2012.

ASM Curriculum Guideline Concept(s): Structure and function, Information flow
Pedagogical Category(ies): Teaching approaches

I3-A
Evaluation of Cooperative Quizzes in a Team-Based Learning Course

Currently, 67% of students enrolled in Virology (n = 15) at MSMU have no prior upper-level molecular biology (MolBio) coursework (Genetics; Molecular and Cellular Biology). Consequentially, most enrolled students last studied MolBio at the end of their first college semester (two years ago), presenting a challenge to grasping viral life cycles. As such, the first 2.5 weeks of Spring 2012 (intro period) were devoted to building a MolBio foundation that would allow students to succeed in Virology. To this end, I developed a survey and MolBio assessment tool to gauge students’ perceived and actual, respectively, pre- and post-intro period MolBio knowledge. I also developed an exercise in which students explored general and MolBio characteristics of Parvovirus B19 through an introduction to online, public-access Bioinformatics tools. I hypothesized that use of this exercise, combined with traditional lecture techniques, during the intro period would increase MolBio and Bioinformatics knowledge and ability to manipulate genetic information. Perceived and actual knowledge after the intro period increased on average 24 pts (scale of 0–64) and 13 pts (scale of 0–37), respectively. Number of students with knowledge of, and ability to work with, specific Bioinformatics tools increased from 4 to 15. It is difficult to say to what degree increased MolBio knowledge was due to the Bioinformatics exercise as opposed to traditional lecture; the exercise has built-in lecture opportunities that were utilized when student responses to exercise questions revealed a need. I conclude that the combination of lecture techniques and the Bioinformatics exercise enhanced MolBio knowledge, and that the exercise itself increased knowledge of, and facility with, specific Bioinformatics tools. To cement this new knowledge, each student will complete the Bioinformatics exercise a second time during Spring 2012, using a virus of their choosing, to demonstrate learned ability to manipulate genetic information and to use Bioinformatics to investigate individual viruses. The results of this second exercise will be obtained and analyzed by the end of April 2012.
Cooperative learning is well established in the literature as a robust and effective way to promote significant learning gains in the classroom. An extension of cooperative learning is the use of cooperative quizzes as both learning and assessment tools in the classroom. I evaluated the implementation of cooperative quizzes within a 400-level Immunology course during the Fall semesters of 2009–2011. Students (n = 63) independently read the text before class, and took an individual quiz on the material before any discussion of the content in the classroom. Students then joined pre-assigned groups and took the same quiz, with each group turning in one quiz that represented the collaborative answers from all group participants. Learning gains were assessed between the individual and group quizzes. Overall, students illustrated significantly increased performance on group quizzes as compared to their individual quizzes, with a median performance increase of 20 ± 10 points (t-test, p < 0.0001). The majority of students (79%) increased their scores with group quizzes, while a smaller number showed either no change (18%) or decreased (3%) performance. Comparisons to individual performance on exams, group dynamics, and the ability of students to answer higher-order thinking questions based upon Bloom’s taxonomy will be discussed. Anecdotal observation suggests greater class discussion and the formation of cogent arguments for correct answers upon utilization of this approach. These data indicate that cooperative quizzes can be a useful tool in the classroom to promote student learning of immunology.

**ASM Curriculum Guideline Concept(s):** Pathways, Information flow  
**Pedagogical Category(ies):** Teaching tools

### 15-A

**Assessing the Impact of Metacognition and Reading Comprehension in Introductory Biology**

K.M. Hill and G.A. Heiberger. South Dakota State University, Brookings, SD.

Current research supports the role of metacognitive strategies to enhance reading comprehension. Biology faculty introduced metacognitive and reading skills to one section of the First-Year Experience (FYE) course for Biology majors (Group 1, n = 63) and only reading skills to the second section (Group 2, n = 51). A research study was designed to measure the effect of these lessons on student performance, metacognitive awareness, and reading comprehension. A pre- and postsurvey design using previously validated surveys was used to collect and compare data to the remaining of the Introductory Biology class (Group 3, n = 261). Pre- and postdata were analyzed by using independent t-test with \( \alpha = 0.05 \). Pre- and postdata showed a statistically significant improvement in metacognitive awareness (\( p = 0.036 \)) only in Group 1. All groups showed a significant improvement in reading comprehension (\( p < 0.001 \) for all). Between groups showed
no significant difference between the two FYE groups in any of the pre- and posttest scores. Group 1 to Group 3 showed a statistically significant difference in post metacognitive awareness ($p = 0.646$ pre, $p = 0.020$ post) and no difference in reading comprehension. Group 2 to Group 3 showed no difference in metacognitive awareness or reading comprehension. When comparing overall course performance, Group 1 did not perform significantly different; however, Group 2 showed a statistically significant difference compared to Group 3 (higher performance, $p = 0.023$). This study suggests that the reading activities as taught did not have a statistically significant impact on reading comprehension. The results do suggest that teaching metacognitive awareness strategies in reading has a statistically significant impact on metacognitive awareness scores, but not on overall course performance. Since the lessons were limited, the treatment will be extended and tested again using a matched pre- and postsurvey design. It is expected that further analysis of the current study will provide additional insight into the interaction of metacognition, high school GPA, ACT, and reading skills on student performance.

**ASM Curriculum Guideline Concept(s):** Structure and function, Information flow

**Pedagogical Category(ies):** Teaching approaches

**16-B**

**Case Studies + Instant Feedback: Targeting Persistent Student Misconceptions in Biology**

A.-M. Hoskinson. University of Colorado—Boulder, Boulder, CO.

Students bring misconceptions to science classes, and some misconceptions are particularly resistant to teacher-centered pedagogical methods. Case studies—stories that elucidate problems to be solved or analyzed—are effective and engaging ways to learn biological principles. This study tested the effectiveness of a case study + IF-AT (instant feedback assessment tool) approach at dispelling misconceptions among introductory biology students, compared to a lecture-only approach. In Spring 2009, students ($N = 347$) took a pretest targeting three common biological misconceptions: A) dominant genes are the best, most common genes in a population (65% with misconception); B) there is no difference in the results of mitosis and meiosis (83%); and C) there is perfect energy transfer among organisms in different trophic levels (77%). During the semester, traditional lectures addressed the three misconceptions. Students took unit exams (1 to 2 weeks postlecture) and a comprehensive final exam (3 to 8 weeks postlecture) in which the pretest questions were embedded. Learning gains were insignificant for two of the misconceptions. For the third, more students held the misconception after the lecture than before. In Fall 2009, the same pretest was given to students ($N = 575$). Misconception responses were not significantly different than Spring 2009. Instead of traditional lecture, student learning in this semester centered on small-group discussion cases. When each case concluded, discussion groups checked their learning with IF-ATs—informal, ungraded assessments. As before, post-test questions were embedded in unit and final exams (2 to 9 weeks postcase). Students converged on correct conceptions significantly more often with the case study + IF-AT approach than with traditional lecture, and the learning gains persisted. There was no significant decay in correct conceptions when measured up to nine weeks postcase.

**ASM Curriculum Guideline Concept(s):** Systems

**Pedagogical Category(ies):** Course design, Teaching approaches

**17-A**

**What Happens When Students Develop and Answer Their Own Questions in Biology Instead of Answering Our Questions?**

J.J. Huang. F.W. Olin College of Engineering, Needham, MA.

This study compares learning gains from two types of assignments associated with the textbook reading in an Introductory Biology course required for undergraduate engineering students. In two sections of the course with different instructors, students are normally given assignments to encourage reading of their textbook for homework. In one section, students take a quiz based on their reading, and in another section, students develop and answer two original questions based on their reading that are Blooms level 2 and above. Students in both sections were surveyed throughout the term at the beginning of class, prior to the start of any classroom activities, using questionnaires to examine student motivation, self-efficacy, and content-related knowledge from their reading for that class time. The results of this study carried out during Spring 2011 and 2012 will be presented. The quantitative data gathered in Spring 2011 did not show significant differences in the areas of student motivation ($p = 0.81$), self-efficacy ($p = 0.28$), or short-term content related knowledge ($p = 0.28$) between the groups of students that completed different assignments. Student self-efficacy with respect to the particular textbook chapter/content read was significant across all students regardless of the homework assignment type ($p = 0.0001$), indicating that student confidence in their knowledge may be correlated with the subject/content of their textbook reading. Qualitative feedback from students who developed their own questions was positive, and suggested differences in the ways in which students read the textbook in preparation to complete the associated assignment. This presentation will include findings of a follow-up study currently underway in the Spring 2012, which includes increased qualitative
data gathering to determine how the assignment types may influence student assimilation of new information. A goal of this study is to determine if encouraging students to assimilate new material through articulating their own questions over time can encourage habits of questioning in general and support student development towards scientific ways of thinking.

**ASM Curriculum Guideline Concept(s):** Structure and function, Information flow
**Pedagogical Category(ies):** Teaching approaches

### 18-B
**Extreme Course Redesign: Applying Scientific Teaching and the ASM 2011 Draft Curriculum Guidelines to a General Microbiology Course**

L.E. Hughes. University of North Texas, Denton, TX.

Several recent calls to action such as *Vision and Change* (AAAS, 2011) have encouraged rethinking the way biology courses are taught. The ASM has been a leader in this movement and the 2011 “Draft Curriculum Guidelines for Undergraduate Microbiology Education” provide a conceptually-based approach to microbiology learning. The draft curriculum guidelines used with scientific teaching approaches will result in a course that engages students and increases retention of microbiology concepts. In the Fall 2011 semester, a general Microbiology course section was redesigned to utilize the concepts of the ASM draft curriculum guidelines as the course learning goals. Specific learning outcomes were written for each learning goal and tied to course activities and assessments. Class activities were developed using scientific teaching approaches. The Student Assessment of Learning Gains (SALG) was administered to students in the redesigned section at the end of the semester. The redesigned section (n = 58) and traditional lecture section (n = 215) had similar overall completion rates (93% redesigned section, 97% traditional), and success rates (students making a grade of C or higher) were both strong (78% redesign, 85% traditional). On the SALG, students indicated “good gain” (4 or higher on a 5 point Likert scale) on four of the concept areas in the draft guidelines (Evolution, Structure and Function, Systems, Impact of Microorganisms) and “moderate gain” (3 or higher) for the other two concept areas (Metabolic Pathways, Information Flow). Students also indicated “good gain” in their enthusiasm for the subject. Overall, the course redesign was successfully implemented as indicated by student success and attitude data. As with any extensive redesign, the initial offering of the new course material provides a starting point to evaluate each activity and identify opportunities for refinement, as shown in examples of course activities developed during the redesign. Combined with the self-reported student gain data, the opportunity for further improvement of the teaching approach is discussed.

**ASM Curriculum Guideline Concept(s):** Impact of microorganisms
**Pedagogical Category(ies):** Course design

### 19-A
**Using Antibiotic-Resistant Bacteria as a Vehicle for Increasing Student Biomedical/Environmental Health Career Awareness and Appreciation for the Adaptability of the Microbial World**

C.H. Hunnes. Rocky Mountain College, Billings, MT.

Educating Biology majors has the ultimate goal of preparing students for a career. Many biology students enter college planning to pursue a career in a health-oriented field. However, many of them are unaware that they can pursue careers that satisfy their interest in medical science in ways other than the traditional tracks of health-care provider. We hypothesized that an elective course could use student enthusiasm for current topics in microbiology as a springboard to expose students to biomedical and environmental health careers. A “Bugs and Drugs” course was offered at Rocky Mountain College, a small liberal-arts school, in 2010 (n = 9) and 2011 (n = 9). After introduction of microbiological concepts, the primary topic, methicillin-resistant *Staphylococcus aureus* (MRSA), was introduced. MRSA was discussed from different perspectives, such as characteristics, infective disease, mechanisms of pathogenesis, mechanisms of antibiotic resistance, transfer of resistance factors, development of new antibiotics, community acquired infections versus nosocomial infections, infection control, antibiotic stewardship, and health disparities. Through one topic, many different career paths were explored in the context of learning the science. Secondary topics, like antibiotic use in animals and *Salmonella* food-borne illness, allowed introduction of the roles of epidemiologists and health inspectors. Surveys given to the students on the first and last day of class showed students’ ability to describe non-health-care provider careers in biomedicine or environmental health increased from 41% to 94%. While only a couple of students changed their first career choice, consideration of a non-provider career as second or third choices increased from 12% to 41%. Whether knowledge of these careers changes the career path of these students will be evaluated postgraduation. In conclusion, this course did increase student awareness and interest in nonprovider career paths. For these students, research and internship opportunities will be important to maintain this interest. This course was approved as a permanent biology elective in January, 2012.

**ASM Curriculum Guideline Concept(s):** Impact of microorganisms
**Pedagogical Category(ies):** Course design
20-B Mining The Immune Epitope Database (IEDB): A Novel Approach to Learn about Infectious Diseases

H. Makhluf. National University, La Jolla, CA.

Students enrolled in Microbiology courses typically struggle with immunology applications. The IEDB (www.iedb.org) houses data related to T and B cell epitopes for humans, nonhuman primates, and other animal species. Biocuration of immune epitope data of NIAID category A, B, and C priority pathogens, as well as emerging and re-emerging infectious diseases, is current and constantly updated. Students querying the database are exposed to a vast, peer-reviewed literature that is dynamic in nature, far beyond the scope of traditional textbooks. We tested the hypothesis that mining the IEDB for Staphylococcus aureus and methicillin-resistant Staphylococcus aureus epitopes would allow students to learn immunology concepts more effectively and in a disease-specific manner. We reviewed the performance of 105 students enrolled in a Microbiology course. Overall students performed better than previous years. The mean percent score per student was 85%, with 100% of students receiving at least 80% on lab reports, exceeding the departmental target achievement. In addition, students consistently indicated a better understanding of B and T cells assays, as well as MHC binding and ligand elution assays. Predominantly, students felt that they gained a better appreciation of scientific advancements and techniques used in studying MRSA. In conclusion, mining the IEDB represents a great innovative tool for microbiology educators demanding seeking to enhance active learning in the classroom.

ASM Curriculum Guideline Concept(s): Impact of microorganisms
Pedagogical Category(ies): Teaching approaches

21-A Creation of a Scholars Program to Breathe Life Back into the STEM Disciplines at a Small College

B.S. Mauck. College of Saint Mary, Omaha, NE.

College of Saint Mary (CSM) created the Marie Curie Scholars Program in order to attract students with high academic potential and proven academic success to our STEM disciplines, thereby improving the overall quality of our STEM programs. A five-year grant was awarded from the National Science Foundation to provide scholarships for STEM students under the hypothesis that recruitment of a few outstanding students would spark an overall improvement in the quality of the STEM programs. Initially six scholarships were awarded each academic year, with the recipients having an average ACT of 23. Enrollment increased, but quality and retention did not. The cohort size was reduced to three scholars per year and the average ACT score of recipients increased to 27. Measureable outcomes support the hypothesis that recruitment of a few outstanding students can have a major impact upon a small department: the percentage of graduates entering graduate school is at 67%; student presentations at scientific meetings has tripled; science fellowships and scholarships now total almost $50,000 per year (not including the NSF grant); average number of hours of student employment in non-science-related employment has decreased by half; and retention of students between the first and second year has improved from 40% to 69%. Standardized content examinations are given during the senior year, but we have no valid comparison data at this time due to a recent change in the examination used. CSM is now funding three scholarships annually, and we continue to recruit students with proven high-academic standards and academic aptitude. Although the grant has ended, we continue to make curriculum changes that incorporate more research experience into standard coursework, and have added a seminar series which will stress scientific thinking throughout the student’s academic career. All STEM students (not just those chosen as scholars), as well as faculty, have benefited from the improved morale, camaraderie, team-building, and energy that resulted from this grant. While the NSF provided the initial funding, this program is being continued by CSM, and the benefits are increasing each year.

ASM Curriculum Guideline Concept(s): Impact of microorganisms
Pedagogical Category(ies): Teaching approaches

22-B Learning “As” Scientists and “From” Scientists: Exploring Scientific Concepts Through Distance Learning

M.V. Mawn. SUNY Empire State College, Saratoga Springs, NY.

The growing interest in online courses presents unique challenges to science educators. Consideration needs to be given not only to the teaching and learning of science content, but also of scientific processes. One approach is to incorporate hands-on investigations and field-based experiments when developing online courses (learning “as” scientists). A second approach is to design asynchronous discussions where students interpret and discuss the scientific literature (learning “from” scientists). To evaluate these approaches, data was collected from four online science courses: three non-majors courses (Study A: Hands-on and field-based experiments, Fall 2007 to Spring 2009, n = 64), and one majors course (Study B: Article review discussions, Fall 2010, n = 40). Assignment instructions and student submissions were analyzed for 16 Elements of Scientific Inquiry, and pre-/post-surveys measured the impact of...
article reviews on student learning. Findings show that students who engaged in experimentation consistently applied five out of 16 scientific inquiry elements: learner engages in a scientific investigation, collects data, analyzes data, uses quantitative methods, and communicates with others. Nine elements were sometimes observed, while two elements (formulates a testable hypothesis, uses qualitative methods) were not observed. When reviewing scientific articles, students “strongly agreed” or “agreed” that this positively impacted their learning, specifically, that “Reading scientific journal articles increased my understanding of scientific a) content (95%); b) process” (79%). In addition, 93% of students reported they would be more likely to read scientific articles. These findings have implications on online science course design. Students generally completed experiments as directed and did not explore further. If a desirable outcome is: “Learner makes predictions,” this should be included in the activity design. Similarly, article reviews that explicitly ask students to identify the authors’ hypothesis and variables tested would solidify their understanding of scientific processes.

ASM Curriculum Guideline Concept(s): Systems
Pedagogical Category(ies): Course design

23-A
Does the Use of Interactive Exercises Using Three-Dimensional Models of DNA in an Undergraduate Microbiology Class Enhance Learning of DNA Concepts?
A.H. McDonald. Concordia University Wisconsin, Mequon, WI.

The central dogma of biology is an essential but difficult concept for many undergraduates majoring in biomedical science or health science fields. Without a good understanding of the flow of genetic information in the cell, students typically struggle with subsequent concepts of gene expression and viral replication. To enhance learning of the central dogma in undergraduate Microbiology courses, I designed an interactive DNA learning module using three-dimensional models of single- and double-stranded DNA supported with online videos and JMOL models from the Protein Database.

I wanted to determine whether a better understanding of the biochemistry of DNA and its replication would improve student understanding of more complex concepts. Student comprehension of DNA structure and replication was assessed with pre- and postconcept surveys before and after the use of the DNA module, respectively. Questions on the DNA Concept survey were split into two categories, chemistry and biology, and student gains were analyzed using the paired student-t test. Although, the size of the first class of Biomedical Science majors to use the exercise was small (n = 14), the difference in overall scores between the pre (57%) and postconcept (82%) surveys was highly significant (p < 0.005). Student gains in understanding DNA biology were generally greater (p < 0.005) than for DNA chemistry (p < 0.05), but both high and low scoring students on the preconcept survey showed significant improvement (p < 0.05) and in both areas. However, when the effectiveness of the exercise was assessed by a retrospective comparison of exams from previous semesters, significant gains were generally only seen in those topics demonstrated in the exercise, with the exception of transcription and bacterial genetics (p < 0.05). Although, these results must be considered preliminary, they do indicate significant gains in student learning. Therefore, further studies using the exercise in larger microbiology classes seem warranted and are currently in progress.

ASM Curriculum Guideline Concept(s): Structure and function, Information flow
Pedagogical Category(ies): Student learning, Teaching tools

24-B
Adapting a National Model for Incorporating Research Projects into Introductory Biology Courses
K.M. Mogen and K.K. Klyczek. University of Wisconsin-River Falls, River Falls, WI.

Undergraduate research is a high-impact educational activity, widely believed to encourage students to pursue advanced degrees and careers in science. Our goal was to engage freshmen in authentic research in their Introductory Biology course. We compared two models for research-based courses. The Phage Hunters Advancing Genomics and Evolutionary Science (PHAGES) program, sponsored by the Howard Hughes Medical Institute Science Education Alliance, was implemented in one course section in 2010–11 and 2011–12. Implementing the PHAGES course at our institution required additional lab time and one additional credit, and the students were selected based on interest and preparation. Students isolated and characterized novel mycobacteriophages from soil during the Fall semester. In the Spring semester, they annotated a complete phage genome and conducted research into the biology of the new phage. In Fall 2011, we incorporated the principles of the PHAGES project into two additional introductory course sections, without additional lab time, without additional credits, and without any preselection of students. We hypothesized that students would still be able to contribute meaningful data to a collaborative research project, and that the experience would still enhance their interest in pursuing biology research careers. The new course lab sequence focused on honey bee biology, and included research into possible causes of colony collapse disorder (CCD) in collaboration with the Bee Lab at the University of Minnesota. qRT-PCR was used to test whether pesticide-treated bees had increased levels of viruses associated with CCD, compared to untreated
bees. Students successfully completed the research goals and obtained good quality data. Surveys in both classes indicated that, for the majority of students, the experience positively influenced their intentions to pursue science careers. We conclude that it would be beneficial to incorporate this approach into all of our Introductory Biology classes. Follow-up assessment is planned to determine whether these students seek addition research opportunities and continue in science careers.

**ASM Curriculum Guideline Concept(s):** Impact of microorganisms  
**Pedagogical Category(ies):** Course design

**25-A**  
**Murder in Cancun: Using an Interactive Case Study Approach to Improve Introductory Biology Students’ Understanding of Restriction Digests and Molecular Biology Techniques**  
J.T. Olimpo and P.A. Shields. University of Maryland, College Park, MD.

Introductory Biology courses, as is perhaps the case across scientific disciplines, traditionally convey content through both lecture and laboratory experiences. However, students often express difficulty in identifying connections between content and real-world, practical applications of what they are learning. To address this concern, we developed an interactive, murder mystery case study designed to introduce students to the concept of restriction length polymorphisms (RFLPs) and the techniques of restriction enzyme mapping, gel electrophoresis, and polymerase chain reaction (PCR). We hypothesized that students would not only gain an enhanced understanding of how restriction enzymes are utilized, but also develop a greater appreciation of how molecular techniques are employed in real-world situations to solve practical problems or tasks. The case study, in which groups of 10 students each were asked to identify the murderer in under 20 minutes, required students to explore three primary concepts relating to restriction digest analysis: a) recognition of palindrome sequences by restriction enzymes; b) amplification and separation of RFLPs via PCR and gel electrophoresis, respectively; and c) interpretation of restriction digest results to compare DNA profiles. Postsurvey data indicated that > 80% of students (n = 193) found the activity beneficial and that students’ self-reported comprehension of the above concepts was significantly enhanced beyond their reported understanding from lecture and laboratory experiences alone (p = 0.037). In addition, interview data demonstrated that, as one participant stated, “understanding restriction digests makes more sense because [I] can now picture how [the technique] is used more big picture for genetic purposes.” Together, these data suggest that student learning in introductory courses and their appreciation of the practical nature of scientific techniques and experimentation can be enhanced through the use of interactive case studies in addition to more traditional pedagogical approaches.

**ASM Curriculum Guideline Concept(s):** Structure and function  
**Pedagogical Category(ies):** Student learning

**26-B**  
**Adaptive Evolution of Bacteria as a Hands-On Method for Teaching Evolution to Introductory Biology Students**  
Z.L. Pratt1, G.R. Ruthig2, C.L. Weilhoefer3, and D.G. Oldenburg3. 1University of Wisconsin-Madison, Madison, WI; 2North Central College, Naperville, IL; 3University of Wisconsin-La Crosse, La Crosse, WI.

Evolution is arguably one of the most misinterpreted and conceptually challenging theories of the sciences. A goal for students in an Introductory Biology course is to gain a general understanding of the theory and correctly use its associated terminology. We predicted an interactive laboratory activity would increase undergraduate students’ comprehension of evolutionary theory. The specific learning objectives were twofold: students should understand how (1) environment influences adaptive evolution, and (2) random mutations influence fitness in a given environment. The basis of the lab used the simple, soil-borne bacterium, *Pseudomonas fluorescens* (Pf), which is motile, nonpathogenic, and requires oxygen. In a nonshaking broth environment Pf rapidly and reproducibly undergoes adaptive radiation resulting in a subset of the population that can (via mutation) colonize the interface between the liquid medium and the air. Importantly, these changes in genotype yield easily observed morphological changes of bacterial colonies on agar plates. Using this bacterial model, students discussed evolutionary concepts and their applications both before and after the lab activity. Responses to short-answer questions and matching exercises were evaluated. As of fall 2011, 74 students from an Introductory Biology course at North Central College had participated in this two-week activity. The percentage of students who defined environment as a selective pressure increased from 47% before the lab to 62% after the lab. Initially, 23% of students communicated a misconception of evolution, while only 8% did so after completing the lab; by the end of the lab, 80% fewer students described evolution as an organism’s choice. Finally, genetic mutations were more often identified as random and associated with phenotypes after participating in the lab than before the lab. We conclude that the learning objectives of the lab were met. The lab activity, in conjunction with student-led discussion, increased understanding of evolutionary theory.

**ASM Curriculum Guideline Concept(s):** Evolution  
**Pedagogical Category(ies):** Hands-on projects, Student learning
27-A
Enhanced Student Learning in Genetics via Immedi-
vate Feedback Assessment Technique with Daily
Individual and Group Quizzes
R.A. Puffenbarger. Bridgewater College, Bridgewater, VA.

To assess student learning in genetics, a sophomore-
level fall semester course, I gathered data via a pre/post-
test developed and validated by at Colorado University.
Students at Bridgewater had fairly weak gains on the
posttest in 2007, so I have changed various pedagogical
strategies in order to improve student learning. In 2011,
the posttest data were significantly higher compared to
all other years using a one-way ANOVA (p-values from
< 0.001–0.031). The pretest data in all five years was not
significantly different. What was different in last fall? In
2011, students were quizzed every day on the reading
before lecture started. Each quiz was 10 questions with
four multiple-choice answers. Students were able to mark
answers with 100% of the possible points if they were
confident of their answers, 50%–50% if they had two pos-
sible answers, 50%–25%–25% to give partial credit to three
answers, or 25%–25%–25%–25% to give equal weight to all
answers. After taking the quiz individually, students re-took
the quiz as a 3 or 4 person group using the IF-AT score
sheet from Epstein Educational Enterprises. Anecdotally,
I noticed that students were much more likely to ask for
clarification on quiz questions in 2011 than students in
previous years were to ask questions about the reading
to start class. Student questions in response to the daily
quiz allowed me to address difficulties immediately in
lecture. Some faculty might be daunted by the time and
effort needed to grade daily quizzes. Students can grade
the group quizzes and individual quizzes are scored very
quickly. Educational and cognitive research suggests that
repeated chances to practice recall and peer-discussion
can improve student learning. Since IF-AT quiz format al-

ASM Curriculum Guideline Concept(s): Information
Pedagogical Category(ies): Teaching approaches

29-A
Integrating Outcomes-Based Assessment into a
Multidisciplinary Research-Oriented Laboratory
Curriculum
E.R. Sanders, C. Shapiro, C. Ayon, M. Ko, and M. Levis-
Fitzgerald. University of California Los Angeles, Los Angeles,
CA.

Between 2007 and 2009, we developed and assessed
a research-oriented laboratory course in which students
explore microbial diversity within environmental samples.
We hypothesized that students would realize learning
gains at the highest levels of Bloom’s Taxonomy (HOC5).
To test this hypothesis, we devised an outcomes-based as-
sessment methodology involving rubric-guided evaluation
of embedded course assignments. Performance criteria
were categorized into cognitive process and knowledge
dimensions of a Bloom’s Taxonomy table developed by

ASM Curriculum Guideline Concept(s): Evolution,
Impact of microorganisms
Pedagogical Category(ies): Teaching approaches
Anderson and Krathwohl (2001), cognitive process dimensions were collapsed into HOCS and LOCS, and mean scores for HOCS were tabulated for three sets of assignments spaced over the course of 11 weeks. Comparison of mean scores (m) for HOCS over time (t1, t2, t3) indicated students made gains in content (mt1 = 2.66, mt2 = 3.41, mt3 = 3.62), conceptual (mt1 = 2.50, mt2 = 2.91, mt3 = 3.04), and procedural (mt1 = 2.98, mt2 = 3.14, mt3 = 3.36) knowledge. One-way repeated measures ANOVA results revealed significant differences in all three knowledge categories (pcontent = 0.000, pconceptual = 0.003, and pprocedural = 0.040). Together with supporting evidence from self-report surveys and focus groups, data trends support our hypothesis. These assessment results were instrumental in catalyzing larger-scale curricular changes initiated fall 2010 in which all upper-division laboratory courses in two life science departments were converted into research-oriented experiences. To expand and validate the results of the 2007–09 pilot study, we are applying the same overall methodology using digital portfolios as a means to manage the assessment, annually archiving over 400 student assignments. However, a new challenge entailed creating rubrics with performance indicators that could be categorized into HOCS and LOCS within the context of student learning outcomes (competencies). Application of these tiered rubrics is enabling us to quantitatively measure the impact of the research-oriented curriculum on student learning.

**ASM Curriculum Guideline Concept(s):** Impact of microorganisms

**Pedagogical Category(ies):** Student learning

**30-B**
Team-Based Learning Strategies Enhance Student Success in a Hybrid Microbiology Course

H.M. Seitz. Johnson County Community College, Overland Park, KS.

This study examines the use of team-based learning in a hybrid microbiology course (defined as 1/3 in-class time and 2/3 online content). This research design stems from data collected over four previous semesters that showed hybrid courses had a lower retention rate and lower number of As and Bs compared with traditionally taught sections. Hybrid courses do not have the same opportunities for engagement that more class time provides. Knowing that student engagement can increase student success (success is defined as a letter grade of C or better), I wanted to find a model to incorporate more engagement in the hybrid learning environment. Team-based learning has been previously demonstrated to enhance course retention, increase critical thinking skills, and increase course interaction. By using the team-based learning method I hypothesized that more students would successfully complete the course. To test this hypothesis, two hybrid Microbiology courses were taught. One course used team-based learning, while the other course did not. The same instructor, quizzes, exams, and assignments were used in both courses. Data collected included: weekly quiz and exam scores, letter grades, and student retention. Results showed that a higher number of student’s completed the course in the team-based sections (96%) compared with nonteam sections (76%). More students were successful in the course (87% achieved a C or better) in the team-based section compared with nonteam section (62.5%). And average weekly quiz scores were better in team-based sections (76%) compared with nonteam sections (65%). The only indicator measured that did not show an increase between team-based and nonteam sections was exam scores (74.7% vs. 75.2%). One interesting explanation for the increase in success is that more team-based students reported studying outside of class time with classmates compared with the nonteam based students (44% vs. 22.3%). Conclusions from this study are that team-based learning increases student success and student interaction in a hybrid Microbiology course.

**ASM Curriculum Guideline Concept(s):** Information flow

**Pedagogical Category(ies):** Course design

**31-A**
Using Bioinformatics Tools in the K-8 Classroom: Reinforcing and Extending Fundamental Biological Concepts

M. Shuster1, J. Sandry1, and K. Glazewski2. 1New Mexico State University, Las Cruces, NM; 2Indiana University, Bloomington, IN.

This study examines design, implementation, and evaluation of an innovative elementary and middle school unit. Our research question examines whether a one-week unit on genetics and evolution culminating in a capstone activity using bioinformatics tools can reinforce and teach core concepts in biology as measured by student and teacher performance. We hypothesized that the unit would result in a significant improvement between pre- and posttest scores for K–8 teachers and students. The unit was built, implemented and revised through a tripartite partnership of an undergraduate educator/scientist (who developed the unit and trained the K–8 teachers), teacher educator, and K–8 teachers. Teachers implemented the unit in their classrooms and provided feedback for revisions. Activities included phylogenetic trees, DNA extraction, and genotype/phenotype investigations, culminating in an activity centering on a socially-relevant news event (year one; Yr1) or scientific puzzle (year two; Yr2). Content learning was assessed with a pre- and posttest. In Yr1 the content test consisted of 12 multiple-choice questions addressing broad concepts in genetics and evolution and
material specific to the capstone activity. The Yr2 test had 15 multiple-choice questions in the same general format. Student scores improved significantly between pre- and posttests in both years (Yr1: 12% improvement, \( p < 0.001, n = 318 \) grade 4, 7, \& 8; Yr2: 10% improvement, \( p < 0.001, n = 386 \) grade 7 \& 8). Teachers also showed significant improvement between pre- and posttest in both years (Yr1: 22% improvement, \( p < 0.001, n = 4 \) teachers, \( n = 4 \) schools; Yr2: 16% improvement, \( p < 0.001, n = 6 \) teachers, \( n = 3 \) schools). Yr2 students performed significantly better on the narrowly focused questions based on the capstone activity compared to general conceptual questions (\( p < 0.01 \)). We conclude that teachers can successfully implement an innovative activity using bioinformatics tools (not traditional tools in K-8 classrooms), resulting in small but significant content knowledge improvements by both teachers and students.

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ASM Curriculum Guideline Concept(s): Evolution, Information flow
Pedagogical Category(ies): Teaching approaches

32-B
“Cow of the Future Project” Using a Case Study to Challenge Student Misconceptions about Antibiotic Resistance
A.C. Smith and J. Buchner. University of Maryland, College Park, MD.

Included in the ASM Recommended Curriculum Guidelines is the statement “Human impact on the environment influences the evolution of microorganisms (e.g., emerging diseases and the selection of antibiotic resistance).” We propose that specifically designed active learning activities will support student’s gains in understanding of this statement and will serve to challenge commonly held misconceptions related to antibiotic target and evolution of antibiotic resistant organisms. To test this proposal, we designed the “Cow of the Future Project” aimed at the following learning outcomes: students will be able to recognize that antibiotics interact with microbes not eukaryotes, and students will be able to recognize that antibiotics select for resistant mutants in a population. The project involves a case study, the jigsaw grouping method, face-to-face and online discussions. The project was designed to scaffold the student experience and provide opportunities for formative assessment. Student learning was assessed by evaluation of online discussions, review of the final poster presentation, and via a pre- and postsurvey. Implementation of the project in a General Microbiology course (n = 277) revealed a shift in student responses to the learning outcome related prompts: “Cows may develop antibiotic resistance” and “Overuse of antibiotics induces resistance to antibiotics.” In the pretest, a higher percentage of students agreed with the prompt statement (78.2% and 95.56%, respectively, for the two prompts) as compared to the posttest where percentage of students who agreed with the statement declined (19.5% and 57.25%, respectively, for the two prompts). We concluded from this finding and our assessment of student work using a rubric that learning gains were made by engaging students in the project. Features of “Cow of the Future” include engaging students in review and research teams to research, discuss, and critically assess the use of antibiotics in cattle feed and in genetic engineering experiments. We will report on the project and include further evidence of student learning with examples of student work and direct assessment using a rubric.

ASM Curriculum Guideline Concept(s): Evolution, Impact of microorganisms
Pedagogical Category(ies): Teaching tools

33-A
Self-Guided Peer Discussion is Equally as Effective as Instructor-Guided Discussion Prior to Answering Clicker Questions
N.L.B. Wernick. University of Massachusetts Lowell, Lowell, MA.

This study analyzed whether instructor guided peer discussion prior to answering in class clicker questions enhanced student learning of structure/function relationships in an introductory course for Biology majors. Principles of Biology is a foundational course in which students gain a solid understanding of basic concepts that will be built upon in future courses. Of great concern is the struggle that students consistently face when attempting to make connections between content and larger concepts. They particularly battle with connecting the structure of molecules to their basic biological functions, including that DNA structure dictates protein structure and function. The hypothesis was that instructor-guided peer discussion focusing on structure/function relationships prior to answering clicker questions would enhance student learning. In this study, two sections of a course taught by a single instructor were given identical lectures, clicker questions, and exams. However, one section had self-guided peer discussions prior to answering clicker questions, while the other had instructor-guided discussions geared toward an understanding of structure/function relationships. Results of clicker- and structure/function-related test questions were compared between the two sections, and as an internal control, test results on topics not covered by clicker questions were also compared. The internal control revealed no differences between the two sections (\( p = 0.88 \)). For both clicker question results (\( p = 0.61 \)) and structure/function test questions (\( p = 0.76 \)), students who had self-guided peer discussions scored equivalently as well as those who had instructor-guided peer discussions.
Significantly, all students showed dramatic improvements between their pre- and postopen response test scores, which asked that they describe the relationship between DNA structure and protein structure and function. Thus, all students gained a significant understanding of structure/function relationships, while student- and instructor-guided peer discussions appear to be equally as effective for student learning.

ASM Curriculum Guideline Concept(s): Structure and function
Pedagogical Category(ies): Student learning, Teaching approaches

34-B Integrating Bioinformatics Across the Undergraduate Biology Curriculum
New England College, Henniker NH.

Biology faculty members at New England College agreed that it was important for our majors to understand and be able to use bioinformatics and phylogenetics. All four members of the department attended the American Society for Microbiology/Joint Genome Institute Bioinformatics Institute in March of 2011. Our department set a goal of incorporating bioinformatics and phylogenetics across our biology and health science curriculum. Since this time, several new lab exercises addressing bioinformatics and/or phylogenetics have been incorporated in courses such as general biology, zoology, genetics, microbiology and biochemistry. As an example, in the fall of 2011, students in general biology participated in a new lab module that involved using morphological and sequence data to construct phylogenetic trees. To begin assessing any potential improvement in a grasp of these concepts, we assessed and compared two groups of students in the spring of 2012: those that had previously participated in the new general biology lab module and others that did not have prior exposure to any of the new labs on bioinformatics and/or phylogeny. The assessment tested students on their ability to construct, interpret and answer questions about the construction of phylogenetic trees, using morphological and/or molecular data. The data indicates that 85% of all students tested have the ability to interpret phylogenetic trees. These students were able to interpret the tree regardless of whether or not they had participated in the new general biology lab module (p > 0.05, Chi-square analysis). Constructing these trees was more challenging and only 30% of the students that had the lab module were able to correctly draw a phylogenetic tree and only 11% of the students without the lab could draw a tree. However, this difference was not statistically significant. In order to determine the impact of our curriculum we are developing tools to assess all incoming students on their knowledge of bioinformatics and phylogenetics and then we will assess this population again in their senior capstone course.

ASM Curriculum Guideline Concept(s): Evolution, Information flow
Pedagogical Category(ies): Course design, Teaching approaches

INDEX BY CONTENT

Evolution
Bergeron, L.J. .................................. 34-B
DiGirolamo, L. ................................. 10-B
Hughes, L.E. .................................. 18-B
Pratt, Z. L. ................................... 26-B
Regassa, L.B. ................................. 28-B
Shuster, M. ................................... 31-A
Smith, A.C. ................................... 32-B

Impact of Microorganisms
Baker, J.C. .................................... 1-A
Blewett, E.L ................................... 2-B
Caruso, J.P. .................................... 5-A
Chilukuri, L. .................................. 7-A
Clement, L. .................................... 8-B
Cummings, P.C. .............................. 9-A
Hughes, L.E. .................................. 18-B
Hunnes, C.H. ................................. 19-A
Makhluf, H. .................................... 20-B
Mauck, B.S. .................................... 21-A
Mogen, K.M. ................................. 24-B
Regassa, L.B. .................................. 28-B
Sanders, E.R. .................................. 29-A
Smith, A.C. .................................... 32-B

Information Flow
Bergeron, L.J. .................................. 34-B
Boomer, S.B. .................................. 3-A
Brownell, S.E. ................................. 4-B
Clement, L. ................................. 8-B
Drew, J.C. ...................................... 11-A
Dye, K.E. ....................................... 12-B
Gunsalus, R.P. ................................. 14-B
Hill, K.M. ...................................... 15-A
Huang, J.J. ..................................... 17-A
McDonald, A.H. .............................. 23-A
Puffenbarger, R.A. ............................ 27-A
Seitz, H.M. ..................................... 30-B
Shuster, M. .................................... 31-A

Pathways
Boomer, S.B. .................................. 3-A
Elliott, S.L. .................................... 13-A
Gunsalus, R.P. ................................. 14-B

Structure and Function
Caslake, L.F. .................................. 6-B
Cummings, P.C. .............................. 9-A
Dye, K.E. ....................................... 12-B

19th Annual ASM Conference for Undergraduate Educators
INDEX BY PEDAGOGY

Course Design
Bergeron, L.J. ................................ 34-B
Brownell, S.E. ................................. 4-B
Cummings, P.C. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 9-A
Drew, J.C. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 11-A
Hoskinson, A.-M. ................................ 16-B
Hughes, L.E. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 18-B
Hunnes, C.H. ................................. 19-A
Mawn, M.V. .................................. 22-B
Mogen, K.M. .................................. 24-B
Seitz, H.M. .................................. 30-B

Hands-on Projects
Cummings, P.C. ................................ 9-A
Pratt, Z. L. .................................. 26-B

Student Learning
Boomer, S.B. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 3-A
Caruso, J.P. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 5-A
Clement, L. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 8-B
DiGirolamo, L. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 10-B
Makhluf, H. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 20-B
McDonald, A.H. ................................ 23-A
Olimpo, J.T. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 25-A
Pratt, Z.L. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 26-B
Puffenbarger, R.A. ................................ 27-A
Sanders, E.R. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 29-A
Wernick, N.L.B. ................................ 33-A

Teaching Approaches
Baker, J.C. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 1-A
Bergeron, L.J. ................................ 34-B
Blewett, E.L. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 2-B
Boomer, S.B. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 3-A
Caslake, L.F. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 6-B
Chilukuri, L. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 7-A
Dye, K.E. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 12-B
Elliott, S.L. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 13-A
Hill, K.M. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 15-A
Hughes, L.E. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 18-B
Hunnes, C.H. ................................. 19-A
Mawn, M.V. .................................. 22-B
Mogen, K.M. .................................. 24-B
Pratt, Z.L. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 26-B
Regassa, L.B. ................................ 28-B
Sanders, E.R. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 29-A
Seitz, H.M. ................................. 30-B
Shuster, M. .................................. 31-A
Smith, A.C. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 32-B
Wernick, N.L.B. ................................ 33-A

INDEX BY AUTHOR

Teaching Tools
Baker, J.C. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 1-A
Bergeron, L.J. ................................ 34-B
Blewett, E. L. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 2-B
Boomer, S.B. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 3-A
Brownell, S.E. ................................. 4-B
Caruso, J.P. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 5-A
Caslake, L.F. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 6-B
Chilukuri, L. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 7-A
Clement, L. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 8-B
Hughes, L.E. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 18-B
Hunnes, C.H. ................................. 19-A
Mawn, M.V. .................................. 22-B
Mogen, K.M. .................................. 24-B
Pratt, Z.L. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 26-B
Regassa, L.B. ................................ 28-B
Sanders, E.R. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 29-A
Seitz, H.M. ................................. 30-B
Shuster, M. .................................. 31-A
Smith, A.C. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 32-B
Wernick, N.L.B. ................................ 33-A

Volume 13, Number 1 Journal of Microbiology & Biology Education 123

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