



FOCUS ON MICROBIOLOGY EDUCATION

N E W S M A G A Z I N E

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FEATURES

From the Editor

ABCDE—This issue of *Focus on Microbiology Education* includes Acronyms, Bioinformatics, Collaboration, Development—it's an Eclectic issue. Bioinformatics is a new field, developed with the use of computers to solve problems of handling large amounts of data. That history contrasts with the traditional microbiology with which educators are familiar—after all, the structure of DNA has been known for barely more than 50 years, whereas the Golden Age of Microbiology taught by many microbiology educators goes back to the mid-19th century. The addition of computers to biology means that more resources are available on the one hand, but expenses are increased on the other. Building collaborations can add student power to the equation and can increase both the excitement and results at all levels of education.

This issue combines new techniques with more familiar ones: Kathleen Gabric shares her success with bioinformatics and collaborations at the high school level—look for the excitement in comments from her students. Brad Goodner presented his college-level expertise and the Hiram Genomic Initiative at the 2006 ASM BioQUEST Bioinformatics Institute—read his article and share his enthusiasm for undergraduate research in your own classroom. My own experience at the 2006 ASM BioQUEST Bioinformatics Institute is included for a participant's point of view.

Bridging the experience between traditional and online classrooms, Lee Hughes discovered that teaching an online course helped him to be a better teacher, both online and in the traditional classroom. Erica Suchman, Susan Deines, and Clayton Hurd introduce us to their experiences with service learning and microbiological outreach: their undergraduate microbiology majors teach 8th grade students how to wash their hands effectively. Enjoy the student comments and those of their teachers.

Chris Dobson returns with his career article on becoming a science educator. Check out Jeffrey Byrd's preview of the *Microbiology Education* journal, Volume 7, now on the Newsstands! For practical information, you can't beat the Journal Watch, Web Watch, and right in time the Guide to the ASM General Meeting in Orlando. Happy reading!

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Editor, *FOME*

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FEATURES

Bioinformatics, Collaboration, and Lifelong Learning

Kathleen Gabric
Hinsdale Central High School,
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Kathleen Gabric teaches high school biology to freshmen and sophomores. She has developed high school curriculum utilizing the vast resources offered by bioinformatics as a result of her involvement in a National Science Foundation graduate teaching fellows in K-12 education (GK-12) grant through the University of Illinois. She has presented her curriculum at several conventions, including the American Association for the Advancement of Science (2003) and the National Association for Biology Teachers (2005). Gabric received her B.A. in Zoology from DePauw University in Indiana and an M.S. in Biology from Illinois State University in 1985. She is in her 21st year of high school teaching and serves as lead teacher for the Center for Discrete Mathematics and Theoretical Computer Science Bio-Math Connect Institute sponsored by Rutgers University and the Colorado Institute of Technology.

Imagine a classroom full of 14-year-olds watching their biology teacher and a scientist having a friendly argument over a particular biological process. A week later in that same classroom, the teacher is seated next to her students taking notes along with them as they listen to the scientist speak about proteins and his research. Later, everyone accesses the GenBank databases and begins to analyze amino acid sequences between different species. Talk about lifelong learning! Collaborations with scientists and explorations in bioinformatics ensure that lifelong learning is not just a catchy phrase in your school's mission statement.

In 2001, Steven Moore, a Ph.D. candidate in molecular biology, and I

began to collaborate through a National Science Foundation (NSF) program called NSF Graduate Teaching Fellows in K-12 Education (GK-12) (<http://gk12-uiuc.net/pn761/>). The task set before us was to incorporate the *Biology Student Workbench* and bioinformatics into my high school biology curriculum in a meaningful way. I, like most high school biology teachers, had no training in the field of bioinformatics. As Steve and I worked together, we made connections between bioinformatics and the current biology curriculum. A natural fit between the two exists when studying DNA sequencing, transcription and translation, the role of amino acids in protein functioning, the molecular basis of genetic diseases, and evolutionary relationships. In fact, bioinformatics became the unifying thread of my course as it connected my units on protein structure and function, nucleic acids, cell biology, genetics, and evolution. It improved my students' understanding of how these units are all related; whereas, before each was just an isolated chapter in a textbook. This can be seen through student comments:

Biology Student Workbench has connected our classroom with the rest of the scientific world. It has provided our classroom with information that we

Biology Student Workbench has connected our classroom with the rest of the scientific world. It has provided our classroom with information that we use to strengthen our understanding of science.

use to strengthen our understanding of science. For example, we studied evolution. Using Biology Student Workbench we could find how organisms are related

and how they've changed through evolution of their proteins. With Biology Student Workbench we could line up all the proteins and spot specific sites where they differ.

Using Biology Student Workbench has helped me visualize the material we work with on a day-to-day basis. I can usually understand things better

when I am told about them and then that information is backed up with a visual aid. DNA and amino acid sequences are hard to visualize by yourself and *Biology Student Workbench* makes this type of thing easy to see.

Collaboration with Steve allowed students to become directly involved in the life of a researcher. Steve worked with us over the course of a year, involved students in his own scientific endeavors, and became involved in the students' academic endeavors. This long-term commitment from Steve was very different from having a one-time

guest speaker and helped the students feel important and needed. Since his research involved bioinformatics, we used *Biology Student*

“Of particular note, too, is the professional growth of the classroom teacher, who learned to become a research practitioner. Her awareness of her students' growth shifted toward the analytical, with a keener sense of science education practice and pedagogy.”

Workbench with the students and put the real tools of research biologists in their hands. This hands-on method of teaching was incredibly effective. We found that bioinformatics offered students the opportunity to experience inquiry-based learning, apply real-life data to problem-solving situations, understand how biological concepts are connected, and explore the ethical issues of real-world science. As a result, students were more engaged and had greater ownership of the content and skills they were mastering. Exploring real-world problems and accessing the National Center for Supercomputing Application's supercomputer was a wonderful hook to increase student engagement, as is clear from their comments.

Steve's presence in the classroom has motivated and encouraged me to be involved in science because he has taught me it can be fun and interesting. When we helped him with his protein research, I thought it was interesting to do and it made me feel like I was actually doing real science.

It has made me far more interested because it allows me to see what a real scientist does. Instead of listening to lectures, we were able to do some actual research and participate in some real-life science.

...we are doing something to make a difference. To help someone that is asking freshmen students!! Making us feel more confident, mature, responsible, and needed.

My students were not the only ones who benefited from this collaboration. I gained as much, if not more, than anyone else. Having finished my master's degree

in biology in 1985, my biological knowledge received a much needed update. As I entered

the new millennium, I had a tremendous amount to learn about new technological advances and the new understanding of biology these innovations had created since my graduation. I also learned a lot about teaching. The evaluator for the GK-12 program commented after observing my classroom on several occasions, “Of particular note, too, is the professional growth of the classroom teacher, who learned to become a research practitioner. Her awareness of her students' growth shifted toward the analytical, with a keener sense of science education practice and pedagogy” (1). A benefit that I did not anticipate was the network of contacts that developed as a result of this collaboration. As a teacher, it is very easy to become isolated in your own classroom. I believe the same can be true for a scientist in his/her own lab. Our collaboration resulted in many new doors being opened for both Steve and me.

In conclusion, teacher-scientist collaborations and bioinformatics can provide teachers with opportunities

to update their knowledge base, bring current topics into the classroom, and allow students to experience inquiry-based learning while applying real-life data to problem solving. There are many ways that these collaborations can be initiated. I have collaborated on a smaller scale with students' parents who are researchers by utilizing some of their data and materials in the classroom. Numerous opportunities exist for teachers to update their training in specialized areas through programs for teachers at universities. Many professors and researchers are open to mentoring student scientists who wish to do a research project. I have found that it is worth the effort to reach out and find these opportunities because these collaborations along with bioinformatics can help reform biology teaching and improve the learning experiences for future generations.

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1. **Comstock, S. L.** 2003. Making the case for story: qualitative analysis of technology-rich learning environments. Midwest Qual. Res. Conf., June 18-21, Minneapolis, Minn.

Resources

1. **Biology Student Workbench.** A bioinformatics education portal to “a suite of interactive tools which draw on a host of biology databases.” [Online.] <http://bsw-uiuc.net/>.
2. **Biology Student Workbench Interface.** An educational-oriented interface to the *Biology Workbench* developed for people who have little experience with bioinformatics and associated tools. [Online.] <http://big-horn.animal.uiuc.edu/cgi-bin/sib.py>.
3. **National Science Foundation Graduate Teaching Fellows in K-12 Education (GK-12).** [Online.] http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5472&org=ESIE.

So You Want to Include Bioinformatics in Your Course—Go for it!

Brad Goodner
Hiram College, Hiram, Ohio

Brad Goodner was born and raised in Wichita Falls, Texas. His academic training includes a B.S. in biochemistry from Texas A&M University, a Ph.D. in biology from Purdue University, and a postdoctoral fellowship at University of North Carolina at Chapel Hill. After 7 years as an Assistant Professor at University of Richmond, he has spent the last 5 years at Hiram College where he teaches microbiology, cell and molecular biology, genetics, bioinformatics, and immunology. His research centers on the involvement of undergraduates in several ongoing genome projects using both wet-lab and virtual tools. He is currently Associate Professor of Biology and program director for a Howard Hughes Medical Institute Undergraduate Science Program grant.

As teachers, each of us wants our courses to connect students to the current state of knowledge in a particular area of study, as well to encourage them to take control of their own learning and enhance their problem-solving skills. For many students, hands-on involvement in the lab portion of a course provides these opportunities, and the integration of original research projects into a course can really take it to the next level. While I am a big believer in merging research with our teaching (4), I am the first to admit that not everyone has the funds, facilities, equipment, supplies, and support needed to pull this off. It is safe to say, however, that we all have computer access to the Internet, and we all in some way connect what we teach about metabolism, cell structure, evolution, and pathogenicity to the basics of gene structure and regulation. Given that and a little training in bioinformatics, briefly defined as using computers to mine large biological data sets for useful information, I would suggest that

your students can dramatically enhance their learning of concepts and get their creative juices flowing using information from the more than 200 genomes that are currently in public databases. My goal is to convince you that there is no better time than now to start.

Defining the Problem Space

For the past half century, genetics and molecular biology have allowed us to study individual genes and the proteins they encode. Genomics, or the study of all the genes in an organism, just enlarges the scope of what is possible. Now, instead of asking “is gene X involved in this pathway” or “is gene Y found in both organisms A and B,” one can ask “does this organism have all the genes necessary for this pathway” or “how many genes are common to both organisms A and B.” The term bioinformatics encompasses the tools and their embedded search strategies that allow us to sift through incredibly large data sets to find patterns, quantify similarities, define uniqueness, and visually organize genomic information.

So Many Questions Wait to Be Answered

There is nothing wrong in admitting that we have selfish reasons for learning a new technique because we wish to answer a particular biological question in the lab. The same is true for learning to use bioinformatics tools to answer a biological question. Bioinformatics is most useful when we think of it as a virtual experiment, both in terms of its potential power and of the necessary controls and caveats. As with a lab experiment, it all starts with a great question. To me, the most obvious questions are those that connect to my

course goals, those that connect to my own research interests, and those that allow virtual experiments to lead into wet-lab experiments. Here are a few examples.

In my molecular and cellular biology course, I want my sophomores to nail down the connection between genes, proteins, and biochemical pathways. Over the past few years, I have gone beyond lectures and problem sets to include a multiweek bioinformatics assignment in which each small team

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of students has to reconstruct a biochemical pathway for a particular organism based on its genomic DNA sequence. Students in my

genetics course also start by connecting genes to particular steps in a biochemical pathway then move on to ask more complex questions: has the correct start codon been assigned, are there any extra copies of any genes, are any of the genes of interest organized in operons, and do any of the genes look to be likely candidates for lateral gene transfer.

In terms of my own research interests and connecting virtual experiments to wet-lab experiments, we now have several years of success with testing gene function in one of my favorite organisms, *Agrobacterium tumefaciens*. Each small team of students in the molecular and cellular biology course focuses on a particular gene that has been assigned a putative function based on bioinformatics analyses. Each team then amplifies a small portion of that gene, clones it into a plasmid and checks the gene by restriction mapping, uses the cloned gene fragment to generate a disruption in the wild type *A. tumefaciens* gene, and finally designs and carries out one to two experiments to study their constructed mutant. This all takes place within the lab component of a 12-week course.

The mutants generated can be used by other researchers and quite often spur students to continue their work through independent research projects.

Learn to Use Tools as You Need Them

Students today grew up with computers, the Web, and multitasking, but sometimes we “ancients” (anyone over age 25) are a bit intimidated by computer-based tools. Given the enormity of molecular sequence databases, there is no getting around the need for computer-based bioinformatics tools, but the key is to not get overwhelmed by the number of tools available or by their algorithmic language. First, think about what you need to answer the virtual research questions of interest. For example, if you wish to address questions of gene identity, then you need to understand the basics of sequence similarity searches (e.g., BLAST, Basic Local Alignment Search Tool) and of weak, interrupted pattern analysis

(e.g., models of small protein domains such as the Pfam protein families database) (1, 2). Second, realize that these tools are connected to biological concepts and facts that you already know.

That should give you some confidence that you can understand how these tools work, but more importantly it means that you can maximize the effectiveness of the tools you do use by adjusting their search parameters to match the precise nature of your biological question. For example, if I want to know whether the hexokinase in *Erwinia carotovora* and that in *Escherichia coli* do the same job as a result of common descent (orthologs), I will use one set of tools and parameters. Asking about

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the expanse of the sugar kinase gene family in *E. carotovora* (potential paralog) is a different question requiring different tools or different settings of the same tool.

No Excuses

Plenty of questions wait to be addressed and some incredibly cool tools are available to answer them, so why are you waiting? If you need an invitation, there are plenty around in the form of meetings, books, and websites. Just this summer alone, there are short and long workshops on bioinformatics being run by our own ASM Conference for Undergraduate Educators in Orlando (<http://www.asmcue.org/>), by the National Science Foundation Chautauqua Program (<http://www.chautauqua.pitt.edu/>), and by the BioQUEST BEDROCK Program (<http://bioquest.org/bedrock/>). On the printed page, there are more textbooks and general books on bioinformatics and genomics than I can do justice to here. They range

from literally *Bioinformatics for Dummies* (3) to introductory textbooks such as *Fundamental Concepts of Bioinformatics* (6) to books on specific tools like BLAST (5). On the Web, more and more bioinformatics tools are being organized into workspaces. Besides the well-known National Center for Biotechnology Information (<http://www.ncbi.nlm.nih.gov>), there are tools and tutorials galore on sites such as Biology Workbench (<http://workbench.sdsc.edu>), the Protein Data Bank (<http://www.rcsb.org/pdb>), Expert Protein Analysis System (<http://www.expasy.ch>), the Comprehensive Microbial Resource (<http://cmr.tigr.org/tigr-scripts/CMR/CmrHomePage.cgi>), and the Integrated Microbial Genomes System (<http://img.jgi.doe.gov/cgi-bin/pub/main.cgi>). Find an open door to this incredible area, step inside, and explore. It will be well worth your effort.

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Acknowledgments

I would like to thank all the students at Hiram College and University of Richmond who have participated in bioinformatics research projects over the past 7 years, as well as Jeff Elhai, Cathy Wheeler, and Prudy Hall for helping me to develop and implement these projects.

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ASM BioQUEST Bioinformatics Institute 2006—What a BLAST!

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Lucy Kluckhohn Jones teaches microbiology at Santa Monica College, where she also serves as an ombudsperson. She earned an A.B. in Anthropology/Sociology from Bryn Mawr College, and an M.S. in Biology from California State University, Northridge. With Jeffrey Pommerville she co-chaired the 2004 ASM Conference for Undergraduate Educators.

The American Society for Microbiology hosted the first BioQUEST Bioinformatics Institute, "Evolutionary Bioinformatics: Microbial analyses from sequence to structure to function to ecology," from March 2 to 5, 2006, at its Washington, D.C. headquarters. Twenty-four participants arrived on a chilly Thursday evening; following brief introductions to one another during dinner, we were introduced to the work at hand.

As participants we soon discovered that we are (the present tense is intentional) a diverse group with common interests. We are diverse in our experience with bioinformatics, the use of computer-based tools to analyze molecular data. We arrived from 16 different states and Puerto Rico. We teach at universities and 2-year colleges. We are biologists (our subdisciplines are varied) and mathematicians. Some of us are early in our careers, others may be described as vintage. From preconference introductions we learned that we share many interests, from cooking and reading to music and hiking and horses. We brought laptops—some new, some old, one described as a "coelacanth."

We soon discovered we all spoke the same language: acronyms. The National Science Foundation has funded the BEDROCK initiative (Bioinformatics Education Dissemination:

Reaching Out, Connecting and Knitting-together). Even Beloit College, the teaching home for BioQUEST facilitators John Jungck, Marion Fass, and Ethel Stanley, has its own acronym: BioQUEST Enhances Learning Outwards and Inwardly with Technology (1, inside title page).

Tools

BioQUEST facilitators introduced the mathematical tools we would need to solve problems first as students and then as educators.

John Jungck pointed out that many of us require a math prerequisite to our courses, then don't actually use math in our courses. Using the (ESTEEM) module (Excel Simulations and Tools for Exploratory, Experiential Mathematics, <http://www.bioquest.org/esteem/index.php>), he showed us how to create a bifurcating phylogenetic tree with both a topology and a distance—a tree where the length of the branches reflects the evolutionary history of the microbes involved.

Marion Fass introduced us to the concept of a Problem Space—an unanswered question worthy of exploring and one where data are available for use in the exploration. We looked at HIV as a problem space, both as a closed-ended activity (a dentist whose patients became infected with HIV) and an open-ended activity (the ALIVE study: AIDS Linked to IntraVenous Experience).

Ethel Stanley gave us an overview of the BioQUEST Curriculum Consortium and walked us through the BioQUEST website, as well as the Donor's Dilemma, from *Microbes Count!* (1).

Stephen Everse, Assistant Director of the BEDROCK project, introduced us to the Biology Workbench site at San Diego State University and taught us how to examine DNA and/or protein sequences, group them with BLAST (Basic Local Alignment Search Tool), and create a phylogenetic tree. He is a structural biologist, and with his guid-

ance we explored both the structure of different types of transferrins as well as several web-based tools for viewing molecular structures.

One of the goals of the institute was to promote collaborations between and among colleagues and students. Invited speakers Brad Goodner and Cheryl Kerfeld provided the tools to do so.

Brad Goodner, of Hiram College, introduced the Hiram Genomics Initiative and inspired us to get students involved in research (see his article). He showed us how to help students use BLAST effectively, reminded us to warn our students **not** to print the whole report (40 pages in some cases), and suggested students run the same search 3 days in a row (the answer may change as the database is enlarged).

Cheryl Kerfeld, Director of the University of California, Los Angeles Undergraduate Genomic Research Initiative (<http://www.isic.ucla.edu/ugri/>), described collaboration among students in different courses at UCLA, from introductory students to molecular biology major students. Her students are studying the chemolithoautotroph *Ammonifex dugensi*. Students in one class provide plasma preparations and DNA or protein sequence data for students to use (e.g., with BLAST) in other classes.

The ASM staff provided food, space, support, and tender loving care while we worked. Amy Chang, Kelly Gull, Joelle Roth, and Jean Kayira were all willing and able to answer questions and share their considerable expertise. Many thanks to all.

Students and Educators

In small groups we had an opportunity to become students—investigating data from one of the BioQUEST problem spaces. Some chose to look for LUCA (the Last Universal Common Ancestor) of the West Nile Virus, others chose to explore HIV or transferrins. Our assignment was to present a poster by 10:00 a.m. on Saturday. Like our

students, we experienced the adrenalin rush of a deadline. Then we went out to dine.

Given an overview of available bioinformatics tools and having used them as students we were now expected to produce our own curriculum project, designed to empower students to do something new. We re-sorted into small groups, based this time on a curriculum problem, and set to work. By the end of the Institute, we had each started a project, worked on it, and uploaded it to the BioQUEST website. Sunday morning we shared our PowerPoint presentations, filled with good ideas and good humor. Many participants intend to continue collaborating after the institute and view the projects as works in process rather than as finished exercises.

Lessons Learned

The ASM BioQUEST Institute was empowering. My students have stumbled on several of the tools (including BLAST) and or websites to which we were exposed, but only as visitors. The institute gave me the freedom to try new ideas, and especially the tools with which to do so. In addition, we made friends, colleagues, and collaborators. What a BLAST!

2007 ASM BioQUEST Bioinformatics Institute

The 2007 ASM BioQUEST Bioinformatics Institute has been scheduled from March 8 - 11, 2007. Registration will open in September 2006. Watch www.bioquest.org/bedrock for further information.

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Improvement of Classroom Teaching through Online Course Development

Lee E. Hughes
University of North Texas, Denton

Lee E. Hughes is Lecturer and Undergraduate Advisor in the Department of Biological Sciences at the University of North Texas, Denton. He teaches freshman biology and microbiology, as well as a science methods course for preservice secondary science teachers. He has been teaching a fully online lecture course since 2002 and is currently developing several online graduate courses and a 50% online course for freshman biology majors.

Introduction

Like most new instructors, I had no formal training in teaching before I stepped in front of my first lecture class. Of course, I had several years of experience in laboratory teaching during my graduate studies and even more years of observing teaching styles from a student's perspective. As had been modeled to me for many years by my instructors (2), I taught my course in a standard lecture format. In the semesters that followed, I worked to improve my teaching, yet I did not change the fundamental lecture method by which I taught. This did not change until I began developing a fully online version of one of my classes.

Online Course Development

Several years after that first class, I decided to develop an online version of one of my courses. At the time, there were no online courses being offered by my department. Given that our student profile includes a high percentage of working and nontraditional students, I reasoned that the availability of an online science lecture course would assist these students in their scheduling, even if the associated laboratory was still campus-based. The course I chose to develop in an online format is a nonscience-major's course called

Applied Microbiology.

My university has a strong distance learning program with substantial support services for course development, including short courses for instructors who will be teaching online. I went into these training sessions expecting to learn about technical issues relating to online courseware. To my pleasant surprise, I learned not only how to use the distance learning software, but also how to be a better teacher!

Among the resources we were given in our training sessions was "Seven Principles of Effective Teaching: A Practical Lens for Evaluating Online Courses" (1). This article reinforced the necessity of teaching practices that emphasize interactions between the faculty member and the student, as well as the importance of incorporating active learning and addressing different learning styles. While aware of these issues through experiences in the classroom, this was my first formal exposure to most of these concepts. Armed with new insight, I set about incorporating these ideas into my online course.

I was very aware of the need to compensate for the lack of face-to-face interaction in the online environment. Thus, I incorporated several items to develop community, including an introduction assignment for the students and a welcome video introducing myself. I planned for visual animations to complement my written text, used images throughout the pages to break up the text, and prepared sound clips to assist the students with understanding the pronunciation of terminology and microorganism names. Frequent self-tests were incorporated to help the students assess their learning. I also developed several homework assignments to assist in the development of concepts that I felt might be more difficult to learn in an online environment (Fig. 1).

During the development of this

course, I learned several practical lessons. First, creating an online course requires a lot of time and energy. Fortunately, in my experience, this initial investment pays off through continued use of the materials in future semesters. As well, planning and development of an online course must begin far in advance of actual teaching. While this is also true of traditional teaching, it is doubly important in online teaching. My advice: don't begin to teach an online course while still developing later segments. Finally, it is not always possible initially to implement all the features you want to include. Thus, early versions of my online course lacked the sound clips I had planned, while static figures or crude animations were stand-ins for grander interactions (Fig. 2) that would eventually be added.

Improving Classroom Teaching

Throughout the first several semesters of teaching the parallel online and traditional versions of the Applied Microbiology course, I continued to develop and improve the online course. At the same time, I began to question my approach to the traditional classroom section.

For the most part, little had changed in my teaching style in the lecture course since that first semester. Sure, my delivery and organization had become more polished, and my understanding of which topics were more difficult for the students was improved. But, on the whole, I was not teaching in a greatly different way. I might not have paid attention to this had it not been for my efforts to develop and deliver a good online course.

My goal became to evaluate critically all my teaching and seek continued improvement. The biggest difference was not in the fact that I sought to improve my courses. This had been my goal since I began teaching and is a reason I sought the

Assignment Submission: 2.2 Koch and the Scientific Method

Instructions:

Examine Koch's experiment in the context of the scientific method (See Lesson 2 content module).

Identify each part of the scientific method process and describe briefly (in outline form) how each portion of Koch's experimental process matches to a portion of the scientific method. Each part of the scientific method should begin on a new line followed by your short explanation of the relevant portion of Koch's experiment.

FIG. 1. Sample assignment from the online Applied Microbiology course.

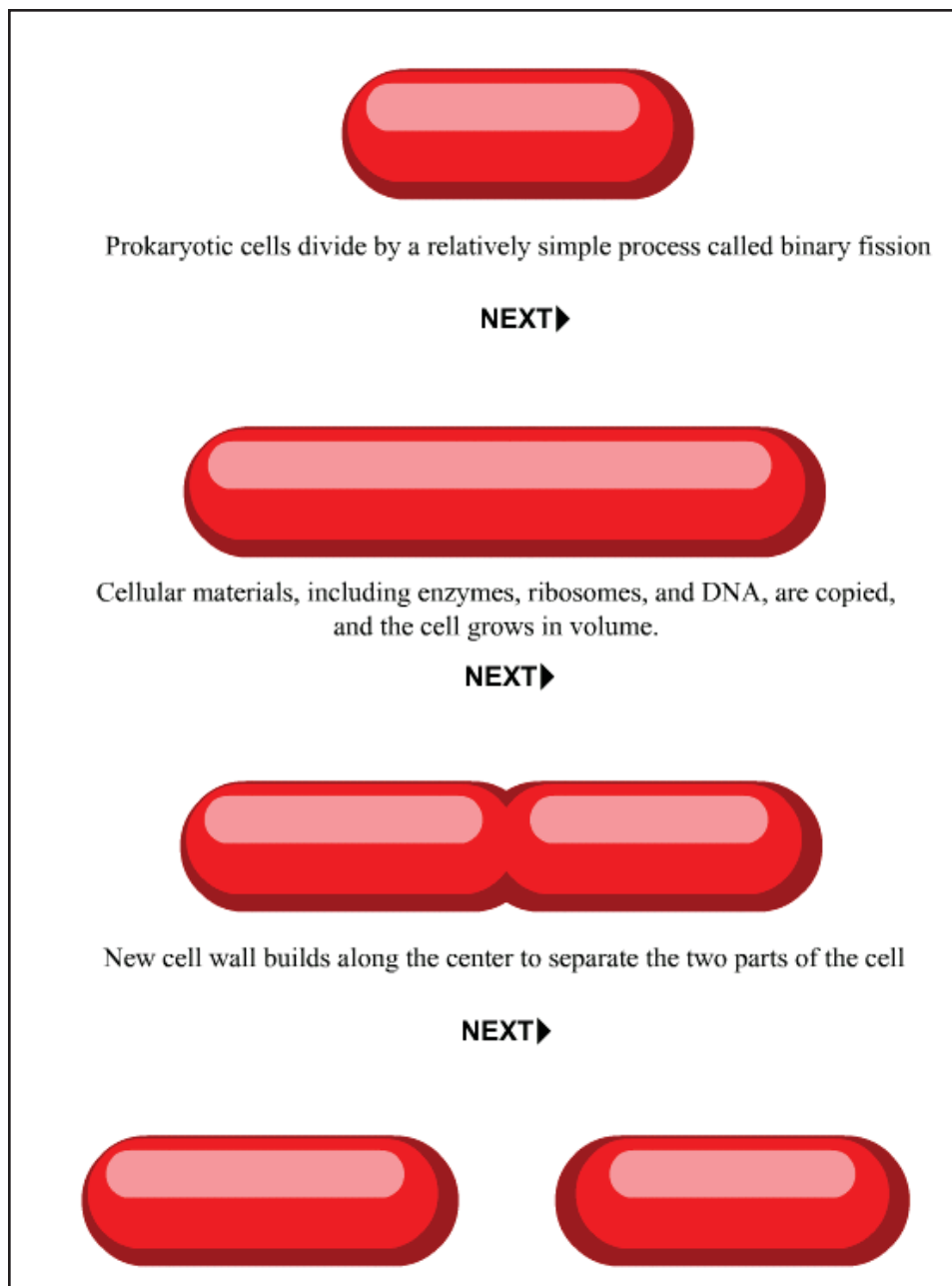


FIG. 2. Snapshots of a sample animation from the online Applied Microbiology course.

opportunity for online teaching in the first place. Teaching online opened my eyes to a number of skills and resources that could be used to improve my teaching, whether in the face-to-face setting or online. My face-to-face course now includes several online supplements, including self-tests and some animations for review. I now have students in the traditional section complete the homework assignments that were originally developed for the online course, and I am working to incorporate more active learning activities into the classroom.

We are all constantly seeking ways to improve student learning in our classes. For me, I find teaching in both the online and traditional classroom to be enjoyable experiences. One thing that I have learned through the process of developing my online course (and now my face-to-face courses as well) is that there is so much to learn. Teaching online has challenged me to examine all my courses and teaching methods. Since I have begun this endeavor, I have been exposed to current research and techniques for the improvement of science education. Hopefully, in this process I am becoming a better teacher and improving my ability to assist my students in their learning.

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1. **Graham, C., K. Cagiltay, B.-R. Lim, J. Craner, and T. M. Duffy.** March/April 2001. Seven principles of effective teaching: a practical lens for evaluating online courses. The Technology Source. [Online.] http://technologysource.org/article/seven_principles_of_effective_teaching/.

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Service Learning in Microbiology

Erica L. Suchman¹, Susan Deines¹, and Clayton Hurd²
 Department of Microbiology, Immunology and Pathology¹, Office for Student Leadership and Civic Engagement², Colorado State University, Fort Collins

Dr. Erica Suchman is an Associate Professor in the Department of Microbiology, Immunology, and Pathology, at Colorado State University. She received her Ph.D. degree in Molecular Biology and Biochemistry at the University of California, Irvine in 1997. She is a member of the Arboviral Infectious Disease Labs (AIDL) where she studies dengue virus' effects on Aedes aegypti mosquitoes, and their potential as biological control agents. She teaches General Microbiology, Molecular and Medical Virology, Virology and Cell Culture Lab, and Service Learning Capstone Microbiology courses. She is currently the chair of the Committee on Technology Enhanced Education, and a member of the Education Board of the American Society for Microbiology. She also serves on the Service Learning Integration Project Faculty Advisory board at CSU and was the corecipient of the Exceptional Achievement in Service Learning Instructional Innovation Award in 2005.

Susan Deines is an Assistant Professor in the Department of Microbiology, Immunology, and Pathology, at Colorado State University. She received her M.S. in Microbiology at Colorado State University in 1995. She holds board certification from the American Society of Clinical Pathologists as a technologist in microbiology. Currently she is the Associate Department Head for Undergraduate Education and teaches General Microbiology, Microbiology for Non-Science Majors, Medical Bacterial Laboratory, and Microbiology Service-Learning Capstone undergraduate courses. In 2005, she and Dr. Erica Suchman were co-recipients of the Exceptional Achievement in Service Learning Instructional Innovation Award.

Dr. Clayton Hurd received his doctoral

degree in cultural anthropology from the University of California, Santa Cruz in 2003. He has directed community-based research and service-learning projects in South and Central America on issues of indigenous rights and education, and in the United States on issues of immigration, education, housing, and health services. He is currently the Associate Director-Service Learning in the Office of Student Leadership and Civic Engagement (SLCE) at Colorado State University. He has previously served as a faculty member in the Department of Education at University of California Santa Cruz and the Anthropology Department at Cabrillo College, Aptos, California.

Anyone who has ever taught a new subject realizes that the best way to learn a subject is to have to teach it. We utilize service learning projects that require our college students to prepare and administer curriculum materials about microbiology for K-12 students. Our students are paired with K-12 teachers who indicate the type of lessons they would like our students to prepare. Students work in groups to prepare the curriculum, course materials, and assessment. They then either teach the K-12 students at their own schools, or the K-12 students come to campus for their lessons.

Methods

“Gross! Is that really in my mouth?” exclaims Emily, a diminutive 8th grade student peering into a microscope. Today, Emily and her 29 classmates are visiting a microbiology laboratory at Colorado State University, where they stain and observe the cells in their mouth, human and microbial, as part of the unit on cellular biology. The four teachers in the room are also students, but not “student-teachers” in the traditional sense. These are microbiology majors, with aspirations to become biotechnologists, research scientists, veterinarians, or physicians.

Service learning is a method of teaching where students learn through active participation in organized service

experiences. Like other volunteer and outreach activities, service learning benefits the community and fosters civic engagement, but it differs from more conventional forms of service in that it is a required part of the academic curriculum that is tied to course content and provides structured time for reflection. Service-learning projects vary greatly, depending on the needs of the community and the interests of the students. For those who teach microbiology, particularly in the area of infectious diseases, integration of service learning into the curriculum seems a particularly daunting task, due to stringent safety regulations that govern work in this area.

We decided the best way to integrate service learning into our undergraduate curriculum was to collaborate with local K–12 schools and have our microbiology students assume the role of teacher. Good teachers have to deepen their own understanding of a topic before trying to teach it to someone else, so it followed that our microbiology majors would also learn more about their discipline by teaching it. We were also aware of the fact that many K–12 students are not interested in science because they perceive it to be boring or irrelevant. And, we know that schools often can't afford the equipment and supplies necessary to do the activities that make science come alive. By providing access to our scientific expertise and teaching facilities, we wished to offer active teaching strategies not feasible in most K–12 classrooms.

We first introduced service learning into our introductory general microbiology course. We were able to integrate a service-learning component effectively into this large class of more than 150 students by requiring the participation of only those students enrolled in the Honors section of the course, or by offering optional participation to interested students. Because most of the participating students possessed a limited knowledge of microbiology,

we chose to present only one service-learning activity in this introductory course. In this activity, called "How and Why We Wash Our Hands," elementary students learn experientially how to wash their hands properly and how proper hand washing and good hygiene help prevent common illnesses, such as colds and the flu. They also sample their surroundings for microbial growth using RODAC (Replicate Organism Detection and Counting) plates. The thin lip of agar protruding from these plates picks up microbes on surfaces, and each microbial cell grows on the agar to produce a visible microbial colony, allowing the elementary students to see the microbes that exist in their environment.

Recently, we created a microbiology service-learning capstone course. Enrollment in this course is limited to ten senior-level microbiology majors. In addition to the hand-washing activity, students in this course create other interactive presentations for students of all ages. One of these activities is the "Medical Mystery" project, in which our microbiology students prepare a case study describing a fictitious disease outbreak and then show 9th to 12th grade students how to perform basic biochemical tests to identify the causative agent. In this activity, the K–12 students come to the university campus and are provided with access to microscopes, reagents, and media not available in their schools. Other projects have included mentoring students in an after-school science program, making soap for nursing-home residents, helping a local church create a composting system for a community garden, and preparing peer-reviewed educational materials for use in MicrobeLibrary.org.

Assessment

In both of these courses, students are required to meet as a class once a week. During that time, they prepare and practice the activities they will present to the K–12 students. They also

reflect on their experiences as a group, by discussing both the successful and problematic aspects of a presentation. Among the questions they consider are: What worked well? What improvements could be made? What mistakes were made and how might they be prevented next time? The students are also required to keep a journal of each project, in which they express their thoughts regarding each presentation. These journals are submitted periodically throughout the semester so the instructors can track each student's progress.

Results

CSU's microbiology students have visited more than 400 K–12 school students each year beginning in 2000. Feedback from students in the courses, as well as from K–12 teachers has been overwhelmingly positive (Table 1).

Research suggests that courses incorporating service learning generally provide greater learning benefits than those that don't (1, 3, 4). By engaging students in rich problem solving and experiential settings, service-learning courses help students develop a deeper understanding of subject matter as well as provide them an opportunity to apply what they are learning to new situations and real-world problems (2). While acquiring this important academic and civic learning, students provide meaningful outreach to people and organizations in need, a service of great value to the community.

Another benefit of service learning is that it fosters leadership, creativity, and teamwork; something that is often difficult to accomplish in a traditional lecture course. We are often surprised by the shy or reticent students who really flower, coming out of their shells to become involved wholeheartedly in their service-learning projects. Furthermore, their participation in this project gives our students a feeling of membership in both the local and scientific communities. In terms of

outreach, our service-learning projects serve as a recruiting tool for CSU, allowing local students to visit campus, participate in meaningful activities, and meet and interact with our university students. Lastly, it allows all students a chance to explore a career they may not have previously considered. There are several cases in which our students have chosen to pursue a teaching career as a direct result of participation in this service-learning project.

Conclusion

We feel that these service-learning activities have been very successful in a dual sense: by fulfilling a community need and by enhancing our students' understanding of microbiology. In our experience, we have found it important to make sure that service-learning projects are appropriate to the student's level of education, realistic in terms of scheduling and time, and give students regular, on-going, and concrete feedback. The most difficult thing about integrating service learning into a course is the faculty time

commitment. It takes time to make the community contacts, coordinate, plan, and carry out the visits, and have proper reflection. We have, however, found it well worth our efforts.

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4. **Steinke, P., P. Fitch, C. Johnson, and F. Waldstein.** 2002. An interdisciplinary study of service-learning outcomes among college students. In A. Furco and S. H. Billing (ed.), *Service learning through a multidisciplinary lens.* Information Age, Greenwich, Conn.

TABLE 1. Comments

CSU student comments	K–12 teacher comments
You really have to learn something to teach it.	Excellent lessons—we learned a lot.
Enjoyed seeing the light go on.	I am very grateful that we got to do this. I watch how our school time is spent and this was well worth our time!
Enjoyed the creativity—different from most science classes.	Thank you. This was a really good experience for my students.
Liked applying what I learned in class.	The [CSU] students are always well prepared, we enjoy them!
I appreciate teachers more now.	

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Note:

The conference will fall on different days next year. The conference will begin Saturday and end Monday. The ASM General Meeting will begin Monday evening.



Becoming a Science Educator

Christopher Dobson
Grand Valley State University,
Allendale, Michigan

Christopher Dobson is Assistant Professor in the Biology Department at Grand Valley State University (Allendale, Michigan) where he teaches biology, ecology, and integrated life science for K–8 teachers. As a biologist and science educator, he is interested in the purposeful improvement of the teaching and learning of science at all levels, specifically the learning of science through scientific inquiry.

I currently work and am well received as a science educator in a traditional biology department at a state university, but what a long strange trip it's been! I debated over titling this article, "Forging a Career as a Teaching Scholar" or "Imposter Stumbles onto Science Education Gig." The truth is probably somewhere in between, but with a tenure decision looming in my not too distant future, I want to err on the side of caution. So now I have a title sounding something like a back-to-school essay topic. My apologies.

My love for teaching was born during my first undergraduate biology course, in which I helped several of my classmates understand cellular respiration. "Why didn't the teacher just say that?" was the response I will never forget. "Maybe I have something here," I thought, and explored the possibility more formally by becoming a tutor. I felt a rush every time I saw the light bulb go off in a student's eyes—I was hooked, hopped up on learning. Of course, I really dove into the pedagogical waters as a graduate student, teaching labs during my master's program in biology. It was sink or swim, and I struggled at first, but eventually learned to dog paddle.

It was not until I entered the Doctor of Arts Program in Biology at Idaho State University (<http://www.isu.edu/departments/bios/DA/index>.

html), however, that I truly began to develop as a professional educator. Like other "teaching doctorates," such as the doctorate in education in biology (Ed.D.) or the doctor of philosophy in biological education (Ph.D.), the doctor of arts degree (D.A.) prepares graduates as broadly trained biologists capable of both effective college-level teaching and research methods appropriate to biology and to education.

Degree requirements allowed me the flexibility to design my program, to some extent, and conduct educational research. With an eye toward my future teaching, I investigated the development of critical thinking skills in anatomy and physiology students (2). The program also required successful completion of supervised teaching internships. I taught several lecture courses, in which I was responsible for curriculum development and student assessment. Evaluation of my teaching was an integral component of these experiences, with substantive feedback coming through regular attendance by the supervising faculty as well as videotapes of my lectures. I never realized how much I talked with my hands!

During my first internship, I vividly remember my initial attempt to use a "minute paper," one of the classroom assessment techniques outlined in Angelo and Cross (1). I had just completed the world's best lecture on meiosis—I know because I was a graduate student with all the time I needed to prepare, a luxury I have not experienced since. I had students anonymously answer a couple of questions, on "3x5" index cards, that I had designed to gauge their understanding of the lecture's content. That night, as I read through the cards, I realized that 44% of the class had what I considered to be at least one major misconception about the process of meiosis.

My first thought was, "If this is the result of my best effort as a teacher, maybe I should go back to Oregon and take up plumbing with my cousin

after all." My second thought was that I could correct these misconceptions at the beginning of the next lecture, before the upcoming exam. My heart raced as if narrowly missing a head-on collision. I realized that had I not conducted the assessment, I would not have discovered the widespread lack of understanding until grading the exams. At the risk of overstating the moment, it was **my** epiphany.

From that moment, I began to adopt a more scholarly approach to teaching. I now feel compelled to continually explore my effectiveness as an educator. In other words, I have become a researcher in my classroom. I use various assessment techniques as a microscope to examine my teaching more closely. I have learned to couple personal reflection with the results of this assessment to make informed modifications to my methodologies. The power of this mechanism lies in my ability to reach conclusions about my teaching and student learning based on the collection and analysis of data. As a scientist, this approach is not new to me. I have just begun to apply the same investigative mindset to my classroom, rather than to rely on gut feelings about how things are going.

The application of an investigative approach towards one's teaching is necessarily what transforms a bench-science scholar into a teaching scholar. A thirst for rigorous inquiry, underlying the scientific method, drives an authentic assessment of student learning. Specific research experiences can facilitate the teaching of science as well. National standards for the teaching of science (3) exist and state that students should learn science by doing science. That is, they should engage in the process of science. The goal of this approach is that, in addition to learning science content, students learn about the nature and methods of science. Who better to help them understand the process of science than a veteran researcher with colorful war stories that

make the science come alive?

Becoming a teaching scholar, however, does not necessarily limit one's opportunities for doing science. Through my involvement in teacher preparation, I guide students through extended scientific investigations, in which they ask their own questions, practice experimental design, conduct data collection and analysis, and present and defend their conclusions. Mentoring these students and watching them develop is not unlike supervising graduate students in a laboratory setting and is more fulfilling than I would have ever imagined. Because their investigations address their own questions and are unrelated to my personal research interests, the experience is authentic and the excitement for science is contagious. Less concerned with publication, I feel free to let my students make their own mistakes and learn from them—a more accurate representation of the scientific process.

Another primary responsibility of my position, as a science educator, involves K–12 outreach. Through state and federally funded projects, I interact with elementary and middle school teachers

at local school districts to impact their students directly. This includes presentations and workshops to update the teachers' science content, as well as to highlight best practices for the teaching of science. I have also mentored several middle school teachers and their students in research projects that resulted in presentations at various Michigan teaching conferences. Grants are available to support this type of work, and the *No Child Left Behind Act* of 2001 specifically calls for the engagement of science and mathematics faculty toward this end. The successful grant-writing skills of an accomplished researcher, who is making the transition from bench-science scholar to teaching scholar, are an invaluable asset in securing money for these activities in public schools that are in desperate need of funding.

I feel extremely fortunate to be in my position. I am paid to teach undergraduate biology, my first love. I also impact science education at the K–12 level through my individual research, involvement in teacher preparation, and outreach to the teachers and students in local school districts. If you're inter-

ested in exploring a career in science education, one easily accessible inroad is through outreach. Volunteer at one of your local informal science institutions that conduct educational outreach, such as zoos, museums, or nature centers. If you have children, visit their schools and speak with their teachers. If not, contact the curriculum director for the school district in which you live to see where your expertise fits into the curriculum and get involved.

References.

1. **Angelo, T., and K. Cross.** 1993. Classroom assessment techniques: a handbook for college teachers. Jossey-Bass Publishers, San Francisco, Calif.
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3. **National Research Council.** 1996. National science education standards. [Online.] <http://www.nap.edu/reading-room/books/nses/html/>.

ASM Fellowship Programs in Microbiology

ASM's Education Board sponsors a variety of fellowship programs for postdoctoral scientists, graduate and undergraduate students. Below is a listing of the fellowship programs available.

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**On Your Newsstands Now:
Microbiology Education,
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Jeffrey Byrd
St. Mary's College
Editor in Chief, *Microbiology
Education*

A volume of a journal is framed by the types of submissions received. This seventh volume of *Microbiology Education* contains a set of papers presented by instructors at larger institutions that address some of their educational challenges regarding student engagement and critical thinking.

In a large lecture course it is essential to determine if all students are following the topic under discussion, not just those participating in the discussion. In the first paper by Suchman et al., the use of classroom response system technology is examined in their microbiology course. This paper provides a thought-provoking study of the usefulness of this type of system and a discussion of potential problems. Once you know the class is on task the next step is to make sure you are stimulating critical thinking. Merkel et al. present

a paper in which they discuss a set of web-based case studies in microscopy. Through the use of this assignment they determined that the students utilized the knowledge gained and applied these techniques to real world scenarios.

While the first two papers deal with undergraduate classroom issues, the third article by Rios-Velazquez et al. examines how to encourage engagement of high school students during summer programs. Through a cooperative model of student engagement, Upward Bound science and math high school students visiting Inter American University of Puerto Rico, Ponce, worked together to discover the fundamentals of the scientific method. As a microbiologist it "warms my heart" to see microbiology used as the mechanism to stimulate scientific thinking, especially for the group that this summer program is trying to reach.

As always, I hope you find that these papers enhance your knowledge of teaching and learning and that they stimulate you to think about analyzing the wonderful techniques you use in your classroom. *Microbiology Education* stands ready to publish your hypothesis-driven scholarly findings.



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by Erica Suchman, Kay Uchiyama, and Kim Bender

An Evaluation of Web-Based Case Studies in Microscopy

by Susan M. Merkel, Marilyn Dispensa, and William C. Ghiorse

The Delta Cooperative Model: a Dynamic and Innovative Team-Work Activity to Develop Research Skills in Microbiology

by Carlos Rios-Velazquez, Reynaldo Robles-Suarez, Alberto J. Gonzalez-Negron, and Ivan Baez-Santos



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An Educator's Guide to the 106th General Meeting of the
 American Society for Microbiology
 Orange County Convention Center (OCCC), Orlando, Florida
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Sunday, May 21

3:00 - 4:30 PM
Techniques for Delivering a Successful Presentation
 OCCC, Room 110

Monday, May 22

7:30 - 7:45 & 10:30 - 10:45 AM
Student Orientation
 OCCC, Room 110

10:45 - 11:45 AM
ASM Fellows Student Oral Presentations
 OCCC, Room 304G

1:00 - 2:00 PM
ASM Fellows Student Oral Presentations
 OCCC, Room 304G

2:30 - 5:00 PM
What a Time to be Alive for the Microbiologist of the 21st Century
 OCCC, Room 415C

2:30 - 5:00 PM
The Use and Potential Misuse of Microorganisms: The Impact of Select Agents in Teaching Microbiology
 OCCC, Room 206A

Tuesday, May 23

10:45 - 11:45 AM
ASM Fellows Student Oral Presentations
 OCCC, Room 304G

Tuesday, May 23 (cont)

10:45 - 12:00 Noon
Division G Student Oral Presentations
 OCCC, Room 300

1:00 - 2:00 PM
ASM Fellows Student Oral Presentations
 OCCC, Room 304G

1:00 - 2:15 PM
Division O Student Oral Presentations
 OCCC, Room 314A

1:15 - 2:15 PM
Division M Student Oral Presentations
 OCCC, Room 308A

2:30 - 5:00 PM
Changing Paradigms in Microbiology: New Techniques, New Perspectives and New Approaches to Student Learning and Carski Award
 OCCC, Room 312A

Wednesday, May 24

8:00 - 10:30 AM
Career Preparation in Microbiology: Pathways and Opportunities
 OCCC, Room 308A

10:45 - 12:15 PM
Richard and Mary Finkelstein Student Oral Presentations
 OCCC, Room 304A

Wednesday, May 24 (cont)

2:30 - 5:00 PM
Should We Develop Recommended Curriculum Guidelines for Graduate Education in Microbiology?
 OCCC, Room 304E

The Education Board of ASM and the Division W Leadership hope that you enjoy the program that they have put together to ensure microbiology educators get the most out of the General Meeting.

See you in Orlando!



2006 ASM Conference for Undergraduate Educators Poster Presentations

This year, a record number of abstracts were submitted and accepted for presentation at the ASMCUE 2006 meeting to be held May 19-21 at the University of Central Florida in Orlando. We have listed the titles below so you may either look forward to attending to this year's conference or be tempted not to miss ASMCUE 2007 to be held in Toronto, May 19-21.

Course Design

A Constructivist Approach to Teaching a Research-Based Molecular Genetics Course: Development and Evaluation

A. G. Darden, C. D'Huyvetter and M. van Sickle. The Citadel and The College of Charleston, Charleston, SC.

A Problem-Based Learning Strategy for Addressing Issues Related to Ethical, Legal and Societal Issues Flowing from the Human Genome Project

M. D. Boyle and D. M. Braxton. Departments of Biology and Religion, Juniata College, Huntingdon, PA.

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.

The Intersection of Biomedicine, Public Health and Human Rights: A Course on HIV/AIDS

C. S. Chow. Simmons College, Boston, MA.

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.

Opening Vista of Enzymology to Students.... Isolation, Identification, Characterization of Amylolytic Bacteria from Garden Soil and Strain Improvement Studies

S. Vanchinathan. Sri Paramakalyani College, India.

A Discussion Group Program Enhances the Conceptual Understanding Skills of Students Enrolled in a Large Lecture Format Biology 101 Course

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

Development of Measures to Assess Students' Questioning Skills

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

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

C. N. McDaniel, B. Lister¹, H. Roy and **M. H. Hanna**. Biology Department and ¹Anderson Center for Innovation in Undergraduate Education, Rensselaer Polytechnic Institute, Troy, NY.

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.

Effectiveness of a Web-Based Laboratory Course in Biology

* **J. A. Herzog**. Herkimer County Community College, Herkimer, NY.

Using the Transition of Learning to Guide Course Design

W. Huddleston. University of Calgary, AL, Canada.

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.

Germes 101: Design of a Large Microbiology Course for Non-Science Majors

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

Teaching the *lac* Operon in Introductory Biology

L. Roberts and K. Curto. University of Pittsburgh, Clapp Hall, Pittsburgh, PA.

Hands-on Projects

Mining Winogradsky Columns in the Introductory Microbiology Laboratory

D. S. Katz. Rogers State University, Claremore, OK.

A Four-Part Approach to an Adopt-A-Microbe Lecture Project

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

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.

Wastewater Treatment: An Experimental Approach Using Model Systems

A. E. Zayaitz. Kutztown University of Pennsylvania, Kutztown, PA.

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.

Tempeh Production as an Introductory Session to Food Microbiology in an Introductory Microbiology II Laboratory at TRU

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

Use of a Portfolio in a General Microbiology Class to Add Content Flexibility

D. J. Stemke. Elon University, Elon, NC.

Four Inquiry-Based Labs: Do They Help Students Learn Experimental Design?

S. M. Merkel. Cornell University, Ithaca, NY.

Mapping Student Learning Throughout the Collaborative Inquiry Process: The Progressive E-poster

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

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.

Investigation of Coral Disease within Bacterial Biofilm Communities

S. K. Burton and H. M. Lappin-Scott. University of Exeter, England.

16SrDNA and Metagenomic Inquiry-Based Activities to Enrich Learning of Microbial Diversity

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

Geology, Ecology, Molecular Studies (GEMS) at the Cabo Rojo Salterns Microbial Observatory

C. Rios-Velazquez¹, B. Hernández², M. F. Rojas¹, Y. Vega-Bonet¹, P. T. Visscher³ and **L. Casillas-Martinez**². ¹University of Puerto Rico-Mayaguez, Mayaguez, PR, ²University of Puerto Rico-Humacao, Humacao, PR, and ³University of Connecticut, Storrs, CT.

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.

Detection of the Phenazine Biosynthetic Operon as a Novel Way of Teaching PCR

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

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.

The Use of Fluorescence In-Situ Hybridization (FISH) For Detection of Fecal Coliforms as an Undergraduate Microbiology Laboratory Exercise

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

Outreach**Collaborative Project Between Honors Biology Students and Elementary Teachers in Urban Schools to Develop and Deliver Science Curriculum**

C. Chow and R. Kelly. Simmons College, Boston, MA.

The Northeast Biomufacturing Center and Collaborative (NBC²): A Hands-On Approach to Biomufacturing Training

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.

Effective Outreach Materials to Teach Microbiology to Middle School Students

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

Teaching Teachers Using Microbiology

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

Impact of Service Learning and Community Engagement on Learning in a Sophomore Introductory Microbiology Course

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

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

L. Losada. Trinity University, Washington, DC.

Model of a Collaborative Effort: Curriculum Redevelopment of Biotechnology Program

M. Rees, M. Panec, V. Bortolussi and P. Eddinger. Moorpark College, Moorpark, CA.

Teaching Approaches**Considering Sympatric Speciation as Not the Exception: Bacteria as Model Organisms for Evolution**

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

Utilizing Avian Influenza Role-Play to Encourage Microbiology Learning in Non-Science Majors

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

Conversation, Concepts, and Connections: Use of In-Class Student Discussions to Promote Student Learning and Connection of Concepts in Microbiology

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

Analysis of Teaching Strategies to Develop a Global Perspective in Microbiology

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

Enhancing Active Learning in Microbiology Among Undergraduate Medical Students through Case Based Learning (CBL) Sessions

* A. M. Ciraj, P. Vinod, K. Rajani, K. L. Shobha and K. Ramnarayan. Melaka Manipal Medical College, Manipal, Karnataka State, India.

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.

Student Response to the Use of Integrated Content Modules in a Pre-Nursing Microbiology Course

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

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.

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.

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

J. C. Drew and E. W. Triplett. University of Florida, Gainesville, FL.

Use of Literary Works to Convey Disease Impact

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

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.

Integrating Concepts in Lecture Class Using Case Studies

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

Teaching Tools**Using Clickers in the Classroom to Strengthen 'Just in Time Teaching'**

R. A. Gyure. Western CT State University, Danbury, CT.

The MicrobeLibrary Website: What's In It For You?

E. L. Suchman and A. Chang. Colorado State University, Fort Collins, CO, and American Society for Microbiology, Washington, DC.

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.

Astrobiology: Workshops and Websites for Educators

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. Bray² and B. Boufford².¹Department of Medical Microbiology and Immunology and ²Academic 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. Alisaukas. County College of Morris, Randolph, NJ.

<Bold> Presenting Author

05-06 ASM Scholar

* ASMCUE 06 Travel Award Recipient



2006-2007 Cohort of ASM Scholars Named!

Fourteen Scholars have been selected to attend the ASM Scholarship of Teaching and Learning Workshop, July 26-29 at ASM Headquarters. The workshop kicks off an intensive year-long residency to help Scholars develop their abilities to conduct evidenced-based research in microbiology learning.

Godfrey, Susan. University of Pittsburgh, Pittsburgh, PA.

Leavey, Jennifer. Georgia Institute of Technology, Atlanta, GA

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

Losada, Liliana. Trinity University, Washington, DC.

Hagley, Rodney. University of North Carolina, Wilmington, NC.

Renk, Clifford. Florida Gulf Coast University, Ft. Myers, FL.

Hakim, Shazia. Jinnah University for Women, Karachi, Pakistan.

Shanahan, Kristy. Oakton Community College, Des Plaines, IL.

Hughes, Lee. University of North Texas, Denton, TX.

Shaw, Joyce. Endicott College, Beverly, MA.

Kuddus, Ruhul. Utah Valley State College, Orem, UT.

Tor, Jason. Hampshire College, Amherst, MA.

Kuleck, Gary. Loyola Marymount University, Los Angeles, CA.

Volkert, Fredric. State University of New York- Downstate Medical Center, Brooklyn, NY.

Jennifer A. Herzog
Herkimer County Community College,
Herkimer, New York

The focus of this installment of *FOME* is bioinformatics and building collaborations in undergraduate education. When reading the articles below, you will see that I have included some very timely and topical information related to these areas of study. I encourage you to send suggestions, questions or comments to me at herzogja@herkimer.edu. I look forward to hearing from you!

Bioinformatics

DeLong, E. F., C. M. Preston, T. Mincer, V. Rich, S. J. Hallam, N. Frigaard, A. Martinez, M. B. Sullivan, R. Edwards, B. R. Brito, S. W. Chisholm, and D. M. Karl. 2006. Community genomics among stratified microbial assemblages in the ocean's interior. *Science* **311**:496–503.

This is one of the first comparative genomic analyses of microbial communities throughout a continuum of vertical oceanic zones, noting unique gene variations within each stratum.

Mustacchi, R., S. Hohmann, and J. Nielsen. 2006. Yeast systems biology to unravel the network of life. *Yeast* **23**:227–238.

*The authors provide a description of the newly established Yeast Systems Biology Network (YSBN) and its efforts to establish *Saccharomyces cerevisiae* as a model system for this area of study.*

Sleator, R. D., and C. Hill. 2006. Patho-biotechnology: using bad bugs to do good things. *Curr. Opin. Biotechnol.* **17**:211–216.

*Using *Listeria monocytogenes* as a model organism, the authors propose to exploit the wealth of accumulated knowledge and the unique biology of*

this pathogen to develop novel applications in the areas of biotechnology, food science, and medicine.

Sumby, P., A. R. Whitney, E. A. Gra-viss, F. R. DeLeo, and J. M. Musser. 2006. Genome-wide analysis of group A streptococci reveals a mutation that modulates global phenotype and disease specificity. *PLoS Pathog.* **2**(1):e5.

Using expression microarray analysis, the authors have identified variations in transcriptomes that confer modification in virulence in group A streptococci isolates.

Teeling, H. H., and F. O. Gloeckner. 2006. RibAlign: a software tool and database for eubacterial phylogeny based on concatenated ribosomal protein subunits. *BMC Bioinformatics* **7**:66.

RibAlign is a new computing tool that provides a comprehensive database for ribosomal protein sequences and aids in sequence retrieval, allowing for improved assessment of eubacterial phylogenics.

Waters, A. 2006. Malaria: new vaccines for old? *Cell* **124**:689–693.

*Waters presents a short review of current strategies for malaria vaccine development based upon information gleaned from the recently elucidated *Plasmodium* genome.*

Bioinformatics Pedagogy

Bednarski, A. E., S. C. R. Elgin, and H. B. Pakrasi. 2005. An inquiry into protein structure and genetic disease: introducing undergraduates to bioinformatics in a large introductory course. *Cell Biol. Educ.* **4**:207–220.

This lab activity was developed to expose students to web-based bioinformatics databases, allowing them to use these tools to investigate protein structure and function.

Kumar, A. 2006. Teaching systems biology: an active-learning approach. *Cell Biol. Educ.* **4**:323–329.

Kumar presents a cooperative activity that exposes students to the new field of systems biology by allowing them to interpret data sets to establish knowledge of a complete biological pathway.

Educational Collaboration

August-Brady, M. M. 2005. Teaching undergraduate research from a process perspective. *J. Nurs. Educ.* **44**:519–521.

The authors have developed a research-based course for nursing students, which enhances the learning process by incorporating a collaborative clinical project.

Cooper, H., E. Spencer-Dawe, and E. Mclean. 2005. Beginning the process of teamwork: design, implementation, and evaluation of an interprofessional education intervention for first year undergraduate students. *J. Interprofessional Care* **19**:492–508.

The authors develop a program to implement interprofessional learning in health service fields, but the collaborative practices could easily be implemented in the classroom of other areas of study.

**Volunteer to review
materials or recommend
websites, books,
software or
videos for review.**

MicrobeLibrary@asmusa.org

Gary Kaiser
Community College of Baltimore
County, Catonsville, Maryland

If there is a website you have found useful in your learning or teaching, email it to Gary Kaiser at gkaiser@ccbcmd.edu.

All the Virology on the WWW

<http://www.virology.net/garryfavwebindex.html>

Need information or have questions about viruses? The stated goal of *All the Virology on the WWW* is "to be the best single site for Virology information on the Internet."

Dr. David Sander, the webmaster of this site, has collected a remarkably extensive catalog of virology-related websites and organized the collection under the following headings: Virology Research and Data, Specific Virus Sites, AIDS/HIV Sites, Plant Virus Sites, Treatments/Preventions, Organizations and Groups, Educational Resources, General Virology Information and News, and Internet Sources for Virology. Each of these headings is then subdivided into a variety of useful subheadings.

Another component of this website is "The Big Picture Book of Viruses," a catalog of viral images and virology educational resources (tutorials, online courses, etc.) found on the Internet. Here viral images and their descriptions can be found organized by viral family, by individual viral name, by structure and genome, by host, and by disease.

The site appears to be frequently updated, is well organized, and easy to navigate. It is relevant to any microbiology faculty member or student seeking images or information about viruses.

Doctor Fungus

<http://www.doctorfungus.org>

The website *DoctorFungus* is owned by the DoctorFungus Corporation whose

self-proclaimed purpose is "the timely dissemination of information about fungal infections via the World Wide Web."

The site's home page is divided into a number of user friendly categories, including: Think You Have a Fungal Infection, Think You Have a Sick Building, Learn About Fungi, Antifungal Agents, The Laboratory, MIC Database, Education and Tools, Image Bank, Lecture Bank, and Video Bank. Each of these topics is subdivided into subcategories. For example, the category "Think You Have a Fungal Infection?" includes fungal infections In People, In Animals, and In Plants; the category "Learn About Fungi" contains General Discussion, Pictures of Fungi, Descriptions of Fungi, and Fungal Synonyms.

The extensive Image Bank includes an excellent collection of photographs illustrating both macroscopic and microscopic fungal morphology as well as many pictures showing human, animal, and plant mycoses. The section on Antifungal Agents is also of value.

The site appears to be frequently updated and is easy to navigate. It is relevant to any microbiology faculty member or student seeking images or information about fungi.

Marine Microbiology: Microbial Wonders of the Deep

<http://www.thesecondlayer.com/marine/>

This is a fairly small website by Kiran Parghi at the University of British Columbia that provides a very nice overview of marine psychrophiles, thermophiles, halophiles, and barophiles. Each group is described in terms of its habitat and the microbe's adaptations for that environment, including membrane stability, protein and enzyme stability, nucleic acid structure, and gene regulation. Brief sections on marine ecology and bioluminescence are also provided.

The website resembles a PowerPoint lecture and might provide a useful online class activity or resource for introductory microbiology students when extremophiles are being taught. It would take a student less than 30 minutes to review the site. The only date found on the site is 2002.

Website for the USDA Food Safety Research Information Office

http://fsrio.nal.usda.gov/path_contam.php

The website for the U.S. Department of Agriculture Food Safety Research Information Office is a compilation of online materials related to food microbiology and food science. The site's homepage has an "In the News" and a "Spotlights" section, currently highlighting such topics as Bovine Spongiform Encephalopathy (BSE), Aflatoxin Research, and Bacteriophage Antibiotic Alternative to Benefit Beef Industry. These are generally a fun read.

One can browse the site by the following subjects: Food Processing and Technology, Pathogens and Contaminants, Pathogen Biology, Pathogen Detection and Monitoring, Sanitation and Quality Standards, and Research Programs and Reports. There is a wealth of information here, but as often seen on similar sites, one link lead to this list of links, leads to another list of links, leads to... With patience, the user can eventually find the food-related information required. The search function included can usually simplify the process.

The section on Pathogens and Contaminants is probably the most useful to those either teaching or taking microbiology. This section contains both resource lists and articles in PDF format.

The site is frequently updated but can be a bit complex to navigate. It is relevant to any microbiology faculty member or student seeking images or information about food microbiology.

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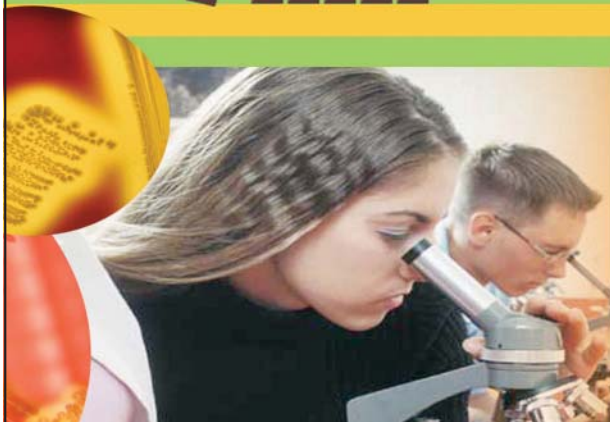
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