The value of laboratory-based learning is as undisputed as the challenges inherent in making the most of the lab experience. How can students gain the lab skills they need and still have time to focus on the concepts being demonstrated? Can an anatomy lab succeed without cadaver dissection? How can introductory students come to appreciate experimental design?

This issue is devoted to strategies for making most of science labs that address these questions and more. As you might expect, computer- and Web-based technology is the key that unlocks the door to some innovative solutions, but others rely on attention to the needs of today's commuter student, use of real clinical data to simulate an investigation, and supporting programs that make lab instructors more effective teachers.

As you read how our contributors have overcome barriers to success in the lab, we hope you will join us in thanking them for sharing their strategies in these pages. It is their—and your—diligence in the “laboratory” of science teaching that makes this newsletter possible.

LABORATORY APPLICATIONS OF A WEB SITE
Joe L. March
University of Alabama at Birmingham

“How do I use this piece of equipment?” As instructors, we have heard that question many times. Typically, we demonstrate a technique at the beginning of a lab period, then monitor and correct the same technique throughout the period. Repeating the demonstration restricts the amount of time we can spend teaching the concepts related to the experiment. About four years ago, a group of faculty and graduate students at the University of Wisconsin-Madison discussed how the Web could be used to give laboratory instructors more time to discuss concepts during the lab period.

A computer Web resource can help to shift the balance between teaching techniques and assessing conceptual understanding back to an acceptable position. The techniques required during any experiment can be anticipated and presented to students at a computer station. The instructor must still observe a student’s technique, but can direct the student to the computer resource instead of continually repeating the demonstration. This minor change in the pedagogy increases the amount of time available for conceptual assessment.

A Web browser is capable of delivering text descriptions, still images, self-tests, and video/audio segments to present lab procedures. While text

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descriptions and still images are also available as printed manuals, the self-tests and video segments provide an interactive atmosphere in which to learn laboratory techniques that printed manuals do not or cannot adequately supply. Additionally, the instant availability of a set of multimedia instructional materials allows students to 1) receive equivalent training on each laboratory technique; 2) correct errors in their laboratory techniques independently; 3) work at their own pace in the laboratory; and 4) easily investigate the usefulness of alternative procedures.

GenChem Techniques Modules

The anticipated advantages of a compilation of laboratory techniques available from the Web resulted in the production of Web modules that describe the majority of laboratory techniques encountered during the first semester general chemistry laboratory experience (see The GenChem Pages found at www.genchem.chem.wisc.edu/labdocs/). The techniques were selected based upon their broad use in many different educational settings—from secondary schools to community colleges and four-year universities. The concept of adding Web modules for lab techniques can be applied across the sciences.

The modules were designed so that students can efficiently access relevant material both in the wet laboratory and as a pre-laboratory resource outside the wet lab. Each module (see Table 1) begins as an outline of the major steps involved in the described procedure. Each major step is linked to the resource material, which is made up of text, still photographs or drawings, video segments with added audio descriptions, and self-check questions.

The Web materials are complete enough to be used independently, but they are expected to be supplemented by a printed manual. Textual descriptions in each module have been minimized so that they describe the technique, but not any specific experiment.

The supplemental nature of the printed manual allows instructors more freedom when choosing laboratory experiments. The Web materials are general enough to be used with a wide variety of experiments. The principles of the techniques are the focus of the module rather than the brand or type of equipment.

One example is the measurement of the volume of a liquid with a graduated cylinder. The module discusses the methods of reading the meniscus on a generic graduated cylinder. Several sizes of graduated cylinders are presented, but the description of the techniques is applicable to a graduated cylinder of any size.

The decision to incorporate video in addition to or in place of still images was carefully discussed at the beginning of the production phase. The benefits of video had to be justified against the amount of time required to download a video from the Internet. Still images are excellent for presenting equipment or explaining how to read scalar quantities, but whenever a piece of equipment must be manipulated, a video with audio instructions is an improvement. For the student, the combination of video and audio creates a mental image of techniques that are often written in a lab manual procedure as a single word or short phrase, e.g., “titrate the sample.”

The videos and stills don’t replace practical experience with a piece of equipment. Undoubtedly, students still need to make mistakes to learn the best way to perform a procedure. However, with the Web resources, students are expected to have a reasonable idea about how to perform a procedure, and the instructor has material to refer students to so that they can recognize their own errors.

Common errors have been included in the modules as self-test questions (short answer or multiple choice).
Laboratory Applications of a Web Site
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Still images and video segments are used throughout the self-tests to present both questions and answers. The questions might contain a depiction of an incorrectly performed procedure or a set of images that contain equipment that is used correctly and incorrectly. In either case, students are expected to make a reasonable attempt at answering the question in their notebook before accessing the answer. Students have unrestricted access to the answers, so there has not been any formal attempt to monitor how students use the self-tests. The student answers, if they have been recorded in their notebooks, have not been collected for assessment.

How Well the Modules Worked

Informal discussions with instructors who have used the modules revealed that they found the modules to be very useful. Some instructors show the relevant modules during the first five to ten minutes of the laboratory period using a computer-interfaced projector. Others only announce to the students that the modules are available at the computer stations. These instructors have noticed that most of the students view the modules at the beginning of the lab.

Regardless of how the modules are introduced, the instructors noted that they were able to refer students to the modules during the lab period and that students responded well to the referrals. As the semester progressed, the students slowly began looking at the modules before asking questions about techniques. In addition, students who had difficulty mastering techniques were able to view the video demonstrations repeatedly on their own. The instructors reported that they now have more time to monitor the class and orally assess conceptual understanding, and that their students are more independent.

Editor’s Note: The GenChem Pages were created as part of the “Establishing New Traditions Project” funded by the National Science Foundation, Grants DUE-9455928 and MDR-9154099. Dr. March is a key contributor to The Chemistry Place™, a rich on-line resource for introductory chemistry students. ■

My Cadaver’s in My Book Bag (or I Left My Cadaver at Home)

Rebecca A. Halyard
Clayton College and State University

A.D.A.M.® Interactive Anatomy (AIA) is now a vital (virtual?) part of the human anatomy and physiology two-semester sequence at Clayton College & State University. Clayton State converted from the quarter system to the semester system in the fall of 1998. Semester conversion presented many challenges in all aspects of the curriculum, but most especially in laboratory courses. An exciting benefit was the opportunity to offer more laboratory experiences.

Armed with a grant from A.D.A.M. Software for the student version of AIA and Mark Lafferty and Samuel Panella’s A.D.A.M. Interactive Anatomy Student Lab Guide, provided by Benjamin/Cummings, we gave AIA a try. We have been delighted with our experience.

Clayton State is a commuter campus. The average student is 28 years old, with at least one job. Each student pays a computer fee and is provided a notebook computer complete with CD-ROM and Microsoft Office 97. The combination of notebook computers and the student version of AIA has provided the exciting opportunity for all students to have a cadaver in their book bag to dissect at a time convenient for them!

Anatomy and Physiology laboratories at Clayton State are typical of most two-semester sequences that serve a large number of allied health students. We study skeletal material, histology, and sheep organs. We carry out basic physiology investigations using Physiograph® and our notebook computers.

This past academic year, each student installed AIA on his/her notebook while in the lab and the instructor, using a data projector, worked through an “introduction to A.D.A.M.” going over the tools and options. Each student made ADAM (or EVE) to look like them and added a fig leaf if he or she desired.

I was amazed to see how quickly students find all the required structures during the first lab. Students try to view each organ from several perspectives: anterior, posterior, lateral, and medial. They learn terminology and spatial relationships at the same time. We prefer to use Dissectible Anatomy when possible, as this gives the student a chance to “dissect” the cadaver. Most students use PowerPoint to make little “slide-shows” of each of the A.D.A.M. labs. They find a required structure and copy it to a slide. They can view this slide...
quickly when time for the practical comes. I understand they also give speeches about human anatomy in speech classes using AIA.

Throughout both semesters, students use AIA to learn the body systems. One lab involves student dissection of a rat, and identifying specified organs. Students find the same organs in AIA and compare the appearance, proportion, and relative size. We do not dissect a cat to learn muscles… we use AIA. We do put a cat on demonstration however (which is not too popular). We then work with the natural-bone human skeleton over a two-week period. Students pull out AIA and keep it on their workstation along with the skeletal materials. They use AIA to help them find required structures on the “real” bones. By this time, they are quite proficient with the “find” tool in AIA and can work quickly.

As students dissect the sheep brain, heart, and kidney, they also use AIA to dissect the human organs of the same kind. They use AIA only to learn specified blood vessels, endocrine glands, and the reproductive organs.

Students are accountable for AIA on the lab practicals. Our practicals are traditional in that the organs are placed on tables with pins in specified structures. We print the material from AIA in highlight mode so that the organ or structure to be identified is clearly highlighted in color. This page is placed in a plastic slipcase next to the specimens. Students tend to perform very well on the AIA questions, rarely missing these. Performance on all questions has improved since we started using AIA.

Students love using AIA, and have had only positive comments. AIA labs can be done off campus after students have learned how to use the software and have taken some practicals to know what is expected of them. Some students still prefer to work on AIA labs on campus with classmates and an instructor. This is, of course, available to them.

We have found this “combo” laboratory (AIA + traditional) to be very successful. AIA has allowed us to provide more instruction and greater convenience to students. And, grades in lab have improved. By the way, we did have some cadavers left at home on lab day…. At least we didn’t have a horrified family member calling us!!

The student version of A.D.A.M Interactive Anatomy will continue to be part of the custom lab package offered at Clayton State.
State LA we use *FlyLab* in both our introductory biology course and our upper division general genetics class. In the introductory course we assign crosses that reinforce some of the simpler principles that are covered in lecture. In the upper division genetics course we run a wet lab where students handle real flies. Toward the end of the course we assign each student two different mutations and tell them to treat *FlyLab* as their own personal “genetics laboratory.” Students design and carry out experiments that will reveal the characteristics of their assigned mutations: Are they dominant or recessive? Autosomal or sex-linked? Lethal or non-lethal? If they are linked, what is their map distance? Students like the freedom and creativity this assignment allows and they learn a valuable lesson in the scientific method. Such an exercise would be impractical using real fruit flies.

Most biology instructors place the scientific method near the top of the list of things they want their students to understand. How we know what we know is at least as important as what we know. That is why all of the *BiologyLabs OnLine* were designed with this goal in mind. For example, using *TranslationLab*, students can recreate some of the early experiments which demonstrated that RNA performs a central role in protein synthesis. Students can create simple messenger RNA polymers which are repeating sequences on one, two, three, or four nucleotides such as UUU…, GCGGCG…, AACAACAC…, or CGACCGACCGAC… As in the original experiments performed in the 1960’s, the mRNA polymers are translated into polypeptides using *in vitro* cell free systems so that translation begins at multiple and random sites along the polynucleotide (no start codon). The number and specific types of polypeptides produced give clues about the genetic code. For example, when GCGGCG… is translated beginning with either the G or C, a single type of polypeptide is produced which is a repeating sequence of two amino acids whereas AACAACAC… produces three unique polypeptides each consisting of a single amino acid, thus providing evidence for the triplet nature of codons. While students can easily look up the genetic code in their textbook, it is still a challenge in logic to design experiments with *TranslationLab* that provide conclusive evidence for specific associations between codons and amino acids. Students leave *TranslationLab* with an appreciation for the hard work and creativity that went into determining the genetic code. They will never again take for granted a codon table.

We all learn from our mistakes. One advantage of using simulations is that they allow us to make mistakes with little or no consequences. Isn’t this why pilots train on flight simulators before they take control of an aircraft? Students who have used the applets in *BiologyLabs OnLine* appreciate the fact that they are allowed to repeat blundered experiments until they get it right. They approach their assignments with less anxiety and a greater willingness to explore on their own. Since the applets are accessible over the Web, they are not limited by available seat time in a classroom, laboratory, or campus computing facility. I see students who are willing to spend many hours working with the applets until they are certain they “have it right.”

Like most biologists, I am convinced that laboratory activities are an indispensable part of a life science curriculum. With *BiologyLabs OnLine*, we can expand this philosophy of “learning by doing” beyond the constraints of traditional “wet labs.” I hope you will give these applets a try.

*Editor’s Note: BiologyLabs OnLine* is a collaborative venture between the California State University and Addison Wesley Longman. It is a subscription Web site that contains several Java-based applets that simulate inquiry-based labs. Also included are supporting materials such as background information and student assignments. Currently, there are eight labs available: *DemographyLab, EvolutionLab, FlyLab, HemoglobinLab, LeafLab, MitochondriaLab, PedigreeLab*, and *TranslationLab*. Two more, *CardioLab* and *EnzymeLab*, will go on-line in early Fall and an additional five labs will be added by the following Spring. The URL is [http://www.biologylab.awlonline.com/](http://www.biologylab.awlonline.com/).
Guidelines for Constructive Feedback in Microteaching

1. Immediately following the teaching segment, the teacher reflects on how the presentation went. One person in the group keeps notes, freeing the presenter from having to respond to or remember everything.

2. Feedback from others is most helpful when it is descriptive and specific, expressing one’s experience in learning during the segment. Evaluative, judgmental comments are best avoided by starting sentences with “I” rather than “you.” Examples of helpful comments: “I felt nervous when you said the paper was worth 50% of our grade.” “I saw the point when you put the diagram on the overhead.”

3. Helpful feedback focuses on behavior that can be modified. “You have a dominating personality” is not helpful. “I didn’t understand all those big words” might be helpful.

4. Feedback should be checked with others to determine the extent of agreement about a particular experience or observation. Is this one person’s impression or is it widely shared? Remember: different students experience their learning in different ways depending on cultural, social, and individual differences.

5. Each microteaching incident raises issues or concerns to be explored as well as problems to be solved.

6. When you are the person receiving feedback, it is best not to feel compelled to respond to each point but rather to listen quietly and try to understand what others’ experiences were as you taught. Ask only for clarification. The moderator will keep notes and make sure that you do not get overloaded with too much feedback.

7. Finally, remember that pointing out strengths is as helpful as exploring concerns. We all have teaching strengths and need to be reminded of what they are.

Strategies for Developing Skills in Teaching Laboratories

Gail Stratton
University of Mississippi

Many first year laboratory programs rely entirely on graduate teaching assistants to teach the laboratory classes. At the University of Mississippi we have an average of 900 students each semester and graduate TAs teach most of the 34 lab sections. To develop the TAs as teachers and to increase the quality of instruction in the freshman laboratory classes, we have introduced a program of practice teaching, called “Microteaching,” modified from the Course Design and Teaching Workshops offered by The Great Lakes Colleges Association. One of the strengths of this program is that it achieves the above goals without adding too much of an additional time burden for Teaching Assistants.

What is Microteaching? Parker Palmer calls this “teaching from the microcosm… small pieces that represent the whole.” Microteaching is a form of teaching laboratory that focuses on the basic premise that there are many different ways of being an effective teacher and that we can expand our effectiveness by observing other teaching styles and strategies and by discussing shared issues of teaching and learning, no matter our discipline, style, or years of experience.

The process is as follows: All of the TAs involved in teaching one class meet with the Lab Coordinator for two hours every two weeks. At each meeting three or four TAs get the opportunity to practice teach by presenting a five minute segment from the introduction for one of the upcoming labs. The other TAs and the coordinator serve as students. The five-minute segment is a “slice” of the lab; it is not intended to be a complete lesson. Those not presenting listen and participate as if they were students, and, when the segment is finished, offer constructive feedback. The presentations may be videotaped. The lab coordinator is the moderator who keeps track of the time and keeps the discussion oriented toward teaching. The moderator also keeps notes, which frees the speaker from having to remember everything. At the conclusion of the five minute presentation, the presenter has the opportunity to reflect on the approach. Did it work or not? What might be done next time? The other participants then reflect on the content and the style of the presentation.

Surprisingly, even a five minute “slice” is enough time to cover a fair amount of material and the TAs find that they need to think through their whole lab exercise to prepare. The TAs have reported that it is particularly helpful to see how others present information on different labs. In many cases, the presentations lead to discussions about much bigger issues (How best to present evolution to students who have always been taught to stay away from it? In teaching about sex and reproduction, is it appropriate to discuss val-
Strategies for Developing Teaching Skills
continued from page 6

ues?). The TAs also report that they get more nervous presenting information to their peers than to their students. It helps the new teachers to see that even veteran teachers still get nervous.

In summary, microteaching provides a practical and effective forum to practice teaching techniques. New teachers get the opportunity to try different ideas and discover the style that works best for them.

Strategies for Developing Teaching Skills
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<table>
<thead>
<tr>
<th>The patient</th>
<th>Normal values</th>
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<tr>
<td>White blood cell (WBC) count</td>
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</tr>
<tr>
<td>Creatine phosphokinase</td>
<td>130,900 U/L</td>
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<tr>
<td>Cerebrospinal fluid</td>
<td>57 WBC/µl</td>
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<tr>
<td>Protein</td>
<td>128 mg/dL</td>
</tr>
<tr>
<td>Glucose</td>
<td>48 mg/dL</td>
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</table>

What conditions could account for these lab findings? What additional tests do you want?

4. The results indicate the presence of infection and infection of the central nervous system. On December 22 a skin biopsy was tested by a direct fluorescent antibody test (FA) and reverse-transcriptase PCR (RT-PCR).

How are these tests performed? For what are these tests used?

5. The FA test was positive for rabies. The sequence of the amplified RT-PCR product showed >99.7% homology to a rabies virus variant associated with eastern pipistrelle bats (*Pipistrellus subflavus*) and silver-haired bats (*Lasionycteris noctivagans*).

What is the significance of the RNA homology between the patient’s sample and bat samples?

6. The patient died on December 31. The RT-PCR test indicates the source of his infection. Additionally, this information can be used to track the spread of a virus through populations. Postexposure prophylaxis (PEP) was administered to 48 people who possibly had contact with the patient between December 4 and death.

How can rabies be transmitted from person-to-person? What is the PEP for rabies?

7. The most likely method of transmission of rabies between humans is contact with saliva. PEP is the injection of antibodies against rabies virus and administration of rabies vaccine.

How might he have contracted rabies? If he was aware of a bat bite, what treatment might have prevented the infection?

Administration of PEP might have prevented his symptoms. Since 1990, 27 human rabies cases have occurred in the United States. Although 20 have been attributed to bat-associated variants of the rabies virus, a definitive history of a bat bite was established for only one of these cases. Although bat-associated rabies virus variants theoretically can be secondarily transmitted from terrestrial mammals, an unrecognized bat bite is the most likely explanation of these cases.

**Fall Workshop Series**

A new chemistry track will complement the life science sessions at the fall Strategies for Success science workshops. The Workshops provide hands-on experience with the latest in educational software and the opportunity to discuss teaching strategies and solutions with colleagues.

- **October 23**, Louisiana State University, Baton Rouge, LA
- **November 6**, University of Richmond, Richmond, VA
- **November 13**, University of Hartford, Hartford, CT

For more information or to register on-line, visit our Web site at [http://www.awlonline.com/bc](http://www.awlonline.com/bc), or contact Strategies for Success Science Workshops at Benjamin/Cummings Science, (800) 950-2665.

**Upcoming Conferences**

**National Association of Biology Teachers (NABT)**

- **October 27-30**, Fort Worth, TX

  With the theme “Biology: A Century of Discovery,” this annual conference explores how discoveries of the last century have changed the way science is taught today. Visit Benjamin/Cummings Science at Booth #418 to see the latest in educational media products. To participate in a non-majors biology focus group, please contact Kirsten Watrud at kirsten.watrud@awl.com.

**Metropolitan Association of College and University Biologists (MACUB)**

- **November 13**, Garden City, NY

  Featuring Keynote addresses by Dr. Bruce Alberts, President, National Academy of Sciences, and Pulitzer Prize Winner Laurie Garrett. For more information, contact: Dr. Kumkum Prabhakar, Conference Chairperson, Nassau Community College, Garden City, NY 11510, (516) 572-8086, or Gary Sarinsky, President, at (718) 368-5503.

**American Society for Cell Biology (ASCB)**

*December 11-15*, Washington, DC

Exhibits, symposia, special lectures, and workshops highlight the 39th ASCB Annual Meeting. Be sure to visit Benjamin/Cummings Science at Booth #1152. For more information go to [http://www.ascb.org/ascb/](http://www.ascb.org/ascb/).

**Society for Integrative and Comparative Biology (SICB)**

*January 4-8, 2000*, Atlanta, GA

SCIB is one of the largest associations dedicated to promoting the pursuit and public dissemination of comparative biology information. Details on SICB’s annual conference can be found at [http://www.sicb.org](http://www.sicb.org).

**HAPS News**

Congratulations to Dr. Mary Ann Ekern of Western Wisconsin Technical College! Her Physiology Media Survey won the top honors from the Benjamin/Cummings Science booth at May’s Human Anatomy and Physiology Society Meeting.

**Sign up for a Focus Group**

Benjamin/Cummings Science will hold focus groups at the fall Strategies for Success Workshops in the areas of non-majors biology, botany, and molecular biology. Contact Kirsten Watrud at kirsten.watrud@awl.com if you are interested in participating.

To participate in the Human Biology focus group at the University of Hartford workshop, please contact Stephanie Kellogg at stephanie.kellogg@awl.com.

**Our Website Has Moved!**

Bookmark the Benjamin/Cummings Science Website’s new address: [http://www.awlonline.com/bc](http://www.awlonline.com/bc). Though still under construction, student and instructor resources, workshop information, and improved product catalog search capabilities are available.