

Sample citation: Burnett, D. W. 1996. Getting the message out: technology equipment for chemistry and biology classrooms. Page 233, *in* Tested studies for laboratory teaching, Volume 17 (J.C. Glase, Editor). Proceedings of the 17th Workshop/Conference of the Association for Biology Laboratory Education (ABLE), 255 pages.

- Copyright policy: <http://www.zoo.utoronto.ca/able/volumes/copyright.htm>

Although the laboratory exercises in ABLE proceedings volumes have been tested and due consideration has been given to safety, individuals performing these exercises must assume all responsibility for risk. The Association for Biology Laboratory Education (ABLE) disclaims any liability with regards to safety in connection with the use of the exercises in its proceedings volumes.

Getting the Message Out: Technology Equipment for Chemistry and Biology Classrooms

Diane W. Burnett

Department of Chemistry, Purdue University,
West Lafayette IN 47907
e-mail address: burnett@chem.purdue.edu

As the methods for exploring scientific phenomena become more sophisticated and instrument dependent, high school students' perception of scientific research becomes progressively more naive. How, then, do you teach laboratory techniques dependent upon instrumental analysis to students when neither instruments nor appropriate experiments are available in high school laboratories? The Purdue University School of Science is actively attempting to find a solution.

The Purdue Instrument Van Project is a curriculum development collaboration of Indiana high school chemistry and biology teachers and the university, currently funded by the National Science Foundation. In five weeks of workshop over two summers, teachers are developing experiments utilizing instrumentation. These experiments are designed to relate to issues that are of interest to high school students, to reinforce chemistry and biology concepts, and to acquaint students with instrumental techniques of analysis. Curriculum modules are written for the classroom which give students an opportunity (1) to explore concepts by demystifying the instruments through simple demonstrations and activities; (2) to develop further understanding of theory through techniques such as guided readings, group discussion, and computer-assisted instruction; and (3) to apply this understanding to actual experiments which use the instruments.

Following the summer workshops, the Purdue Chemobile delivers to the high school classroom sets of smaller instruments such as nuclear scalars, pH meters, Spectronic 20's, microfuges, and electrophoresis apparatus. Larger instruments such as infrared spectrophotometers, scanning ultraviolet-visible spectrophotometers, gas chromatographs, high performance liquid chromatographs, and an atomic force microscope are permanently mounted on rolling carts which also go into the school laboratory. Essentially, the Chemobile is a lending library of instruments available to any teacher participating in the project. Participating teachers represent all schools: rural, urban, suburban, private and parochial.

Introductory Molecular And Cell Biology Courses Open General Discussion

Anne Cordon

University of Toronto
(416) 978-7431 cordon@botany.utoronto.ca

One evening a group of about 30 ABLÉ participants met to discuss introductory level molecular and/or cell biology courses. After comparing information about the general course structure of our various courses, we focused discussion on the laboratory component. The purpose of the interaction was partly to determine the degree of similarity in our respective offerings and partly to discuss our laboratories in context. That is, our laboratories are intentionally grouped together and build on previous techniques and concepts; the labs are not isolated activities. Also, laboratories plus lectures (and sometimes tutorials) make up the whole course.

The ideal outcome of our session would have been a summary statement about a generic introductory molecular and cellular biology course. I also hoped to formulate a wish list of laboratory exercises for future ABLÉ Conferences. Early in the discussion it became obvious that there is no such thing as a common approach to introductory cell and molecular biology! Several main topics were generally covered such as cell form and function; DNA replication, transcription and translation; and enzyme kinetics. However, the breadth and depth of the coverage varied considerably. Correspondingly, the complementary laboratories varied also; consequently, we could not compile a group wish list of labs for future ABLÉ conferences. At least the participants had the opportunity to share ideas and concerns.

The following summary of differences in general course structure and laboratories is based on the small sample of 30 ABLÉ participants and 15 written submissions sent to me before the conference. The first important variable is when the course is offered: many schools' first year course in cell and molecular biology with or sometimes without any chemistry pre/co-requisite. A few schools waited until third year and usually required organic as well as first year chemistry. The other large group of schools introduce molecular/cellular biology in second year with at least first year chemistry and/or biology as prerequisites. At least two schools had no undergraduate course in molecular biology.

The school term and number of lectures and laboratories were two other variables. Most schools have semesters, some have quarters, while full year courses are least common. Most schools have three lectures per week, a small number have two. Biweekly laboratories were more common than weekly.

Some general comments were voiced about laboratories. With greater emphasis on the new molecular techniques, there is less time (no time) to teach basic fundamental techniques, for example, pipetting, making solutions, basic microscopy, sterile technique; using equipment such as spectrophotometers, centrifuges, analytical balances, pH meters; and tissue culturing.

Although the specific lab exercises varied considerably, there were a few types of labs commonly found: labs on enzyme kinetics, organelle isolation, nucleic acid (DNA or RNA) separation, protein separation and analysis, mitosis/meiosis. Far less common were labs dealing with karyology or employing tissue culture.

In conclusion, the discussion group found the forum useful although we discovered more differences than similarities in how and what we teach. The trend for schools to put their course lab outlines “online” will be useful so the material is accessible for specific information.

Simulating a Pond System Over 24 Hours

Jim Eckblad

Department of Biology, Luther College,
Decorah, IA 52101

This workshop describes the use of a computer program (Diurnal Pond Simulation*) that students can use to simulate changes in abiotic and biotic variables within pond habitats over a 24-hour period. The objectives in using this software are as follows:

- To design sampling to best answer specific questions
- To interpret data and look for patterns or differences
- To look for relationships between variables
- To suggest explanations for the observed relationships

Students must first select a sampling scheme. This will include choice of pond (there are six different ones available, but instructors can modify this), season of year, sampling depth (surface, mid-depth, or bottom), sampling frequency, and number of samples at each depth. They may also elect to take samples from each of the three depths.

As every biologist knows, even with the best of planning, you do not have control of the weather. There's a chance component to the weather during any sampling simulation, and the resulting data may reflect differences in weather. There's also a sampling error component such that repeated samples (under the same conditions) will not yield the exact same values. It will also be observed that different aquatic habitats may have different diurnal patterns displayed. For example, a hard-water versus soft-water habitat may respond differently to a day of rain. Or, eutrophic and oligotrophic basins may show different diurnal changes in response to different levels of primary production.

Students will obtain data to estimate nine abiotic parameters (temperature, dissolved oxygen, percent oxygen saturation, pH, alkalinity, dissolved carbon dioxide, conductivity, phosphate, and nitrate-nitrogen) and two biotic parameters (number per liter of phytoplankton and zooplankton). The resulting data can be displayed as either a table or a plot with time along the x-axis.

The questions below illustrate some of the concepts that can be addressed with this simulation.

1. What is the pattern of dissolved oxygen (DO) over a 24-hour period for surface water during the summer?
2. Is the DO profile with depth similar during different seasons of the year in Lindeman Pond?
3. Is the DO profile with depth similar for Lindeman Pond and Eagle Pond?
4. What is the pattern of pH over a 24-hour period for surface water during the summer? How does it compare to the DO pattern?
5. Is the DO profile correlated with any of the other abiotic variables?
6. We often characterize water as being "hard" or "soft". How does this apply to these six ponds?
7. We can also characterize bodies of water as ranging from oligotrophic to mesotrophic to eutrophic. How does this apply to these six ponds?

* Program for the IBM-PC and compatibles and is distributed by Oakleaf Systems, (319) 382-4320

8. Do the nutrients (phosphorus and nitrate-nitrogen) appear to be equally abundant at all depths?
9. It has been reported that some species of zooplankton undergo a vertical migration during each 24-hour period. Do you see any evidence of that in these ponds?

Animals as Factors Shaping Plant Communities

Roy Hurst

Science Education Center
University of Texas - Permian Basin
Odessa TX 79762

In natural communities, plants coexist with many animal species. In addition to the obvious grazing interaction, animals influence the plant's environment in many subtle ways, including physical disturbance, nutrient concentration, seed dispersal, and pollination. Upon closer examination, even the character of the grazing impact may differ between herbivores. All of these complex interactions can act to determine the composition and structure of the plant community.

Students in general biology, ecology, and botany courses can readily investigate the results of such plant/animal interactions by sampling the vegetation in a series of pastures subjected to different grazing regimes. A larger pasture may be fenced into sections which will be grazed by cattle, sheep, and horses, for example. The key is to have at least two, and preferably three, grazing regimes at the site.

Upon arrival at the site, students are given a brief lesson in the mechanics of transects and quadrat sampling. A descriptive key to the plants most commonly found in the pasture is also provided. Teams of students record percent cover by species within quadrats at 10-meter intervals along straight-line transects in each pasture. Bare ground and other features are also noted. The time required for preliminary activities, data collection, and travel is about three hours.

Students calculate average species richness, species diversity, and a dominance-diversity curve for each pasture. Even first-year students seem to gain a greater understanding of how different animals affect the same plant community differently, and they appear to benefit from attempting to explain why the observed differences occur.

Using Commercially Available Human Cells in a Chromosome Lab

Rosamond Potter

Biological Sciences Collegiate Division, University of Chicago
924 E. 57th St., Chicago IL, 60637-5415
rsvp@midway.uchicago.edu

Now that having students prepare and analyze metaphase chromosomes from their own lymphocytes is generally regarded as being too potentially hazardous for a teaching lab, human tissue culture cells are a useful alternative source of metaphase chromosomes to use in a karyotyping lab exercise. HeLa cells (human cervical carcinoma cells which have been in culture since 1952) are now commercially available. The cells are shipped ready for the students to drop on slides; they have been cultured, blocked in metaphase with colchicine, swollen in hypotonic solution, and fixed in acetic acid-methanol (the fixative inactivates the human papilloma virus which is present in the cells). Currently HeLa cells in this useful form are available from CellServ (Kit #4; see below). The cells are stable for at least 4 weeks when stored at -20°C ; one order consists of 15 vials of cells (in our experience these are enough for approximately 150 students to do the lab). CellServ sends two stains to use in combination on the chromosome preps (Eosin Y and Methylene Blue/Azure A); additional stain can be ordered from Baxter Healthcare Corp. (Diff-Quick; see below). The chromosomes can also be stained with Wright-Giemsa stain. We ask students to locate complete, non-overlapping metaphase chromosome spreads on their HeLa slides and then make video prints or digitized images of the spreads to analyze. Because HeLa cells are extremely aneuploid and their chromosomes have undergone many rearrangements during years of culture, their chromosomes are not suitable for constructing a karyotype (when G-banded they are not recognizably human). Hence, we ask the students to construct a karyotype using a provided photograph of a normal, G-banded, human lymphocyte chromosome spread and then to compare their HeLa chromosome spread with the normal with respect to total number of chromosomes and numbers of metacentric, submetacentric, and acrocentric chromosomes.

In addition to providing wet-lab experience in a human chromosome lab, using HeLa cells also stimulates thinking about some interesting questions such as: Except for their origin, in what respects are HeLa cells still human? What different selection pressures act on cells in culture vs. cells in organisms? Should donors of cells (or their heirs) receive payment when cell lines are used in research or used to produce marketable substances (perhaps generating considerable profit)?

Sources of Cells and Additional Stain:

CellServ, CATCMB/103 McCort-Ward Bldg., The Catholic University of America, Washington, D.C. 20064; (202) 319-5725; FAX: (202) 319-4467

Baxter Healthcare Corp., Scientific Products Division, 1430 Waukegan Rd., McGaw Park, IL 60085-6787; (708) 689-8410; FAX: (708) 473-2114

A Hands-On Simulation of Disease Transmission

Jean Dickey

Biology Program, Clemson University
Clemson, SC 29634
dickeyj@clemson.edu

In this laboratory exercise students exchange fluids from test tubes to simulate transmission of disease-causing organisms. Each student has a test tube of dilute (0.001N) HCl, except for one student who is given 0.1N NaOH instead. Since all the solutions are colorless, there is no indication that one is different from the rest. Students pair up and use a disposable pipet to exchange fluids. After three rounds of such contacts with different partners each person tests his own solution with phenol red. All solutions are acidic (yellow) except the original “carrier” of NaOH and any that have come into contact with an NaOH-“infected” solution, which are basic (pink). The transmission route is then traced, and students discuss various aspects of epidemiology and self-protection against disease. A more complete discussion of the exercise can be found in the reference below.

Prep Note

To make 1 liter of phenol red stock solution, dissolve 0.4 g phenol red in 10 ml 0.1N NaOH. Dilute up to 1000 ml with tap water. For this exercise, dilute the stock solution 1:10 with tap water. Use tap water for all the solutions since distilled water is somewhat acidic.

Dickey, Jean L. 1989. A quick and easy simulation of disease transmission. *American Biology Teacher* 51: 364–5.

The Use of Digital Imaging in General Botany Laboratories at The University of Wisconsin - Madison

Mike Clayton

Department of Botany, University of Wisconsin-Madison
Madison, Wisconsin 53706
(608) 262-2333, clayton@facstaff.wisc.edu

For the last three years, General Botany laboratories here have been taught with the use of laboratory imaging systems. Output from these systems is from two ceiling-mounted 32" color monitors placed so as to be clearly visible to students working in their seats. Input comes from either of two color cameras, one on a stereo-zoom dissecting microscope, the other on a compound scope; or from a VCR; or from a teaching computer. Image capture and retrieval is accomplished by means of either tape using a VCR or digitally to a hard drive using a computer.

Experience has shown that TAs are too busy to routinely use the instructional microscopes during laboratory time. A library of images tightly related to the curriculum is necessary for the effective use of the General Botany imaging systems. In the lab, images from a set are presented in the background without announcement and referenced in response to questions, allowing students to work independently without interruption, and providing TAs with helpful images when needed. While dynamic images best demonstrate the relationship between structure and function, video tape is limited because segments cannot be randomly accessed. Two ways around this problem have been developed: by producing long tapes showing the same dynamic phenomenon (such as cyclosis), or by converting video clips into digital movies that can be randomly accessed. For lab use, digital images are also converted into hard copies to produce instructions to guide students through preparations. The output from an inexpensive ink jet printer (Hewlett Packard 550C) has been satisfactory for this purpose.

The image sets developed are also useful outside of lab time. Access by students is accomplished through tutorial computers and through the network. One particular use of this resource outside of instructional times may be of interest. Digital images have been embedded in computer-based dichotomous keys. These keys use images to clearly illustrate the difference between alternate choices in each dichotomy allowing students to use a taxonomic key effectively without first memorizing a set of glossary terms. With use, the student usually learns these terms anyway in a context that makes them meaningful. Dichotomous templates have been written in Macromedia's *Authorware*, and the conversion from a text-based key to a computer key, embellished with color graphics, is simple and easy.

Other educators are invited to use Botany's image sets. Currently five curriculum sets containing over 7,000 JPEG-formatted images are networked. These images may be accessed at the web address, <gopher://gopher.adp.wisc.edu:70/11/.data/.bot>, and may be used for any non-copyrighted instructional use.

Micro-Techniques of Cell Harvesting in Mice

Frances F. Makowski

Department of Biology, University of Portland
5000 N. Willamette Blvd., Portland, Oregon 97203
(503)283-7146, makowski @uofport.edu

Mice are wonderful models of the human immune system. They are used extensively in immunology research and lend themselves easily to undergraduate laboratory curricula and undergraduate research. Micro-techniques of cell harvesting have several advantages when performing studies with mice, including: 1) fewer mice are needed, 2) a single mouse can be monitored throughout the duration of the experiment, and 3) mice need not be sacrificed. The one drawback of these techniques is that studies are limited to peripheral blood analyses. Preliminary results from peripheral blood studies may help to determine the need for further studies for which animals must be sacrificed. We have employed these micro-techniques in our immunology undergraduate research projects and have obtained sufficient quantities of cells to do lymphocyte fluorescent antibody staining, in vitro tissue cell culturing and mitogen stimulated lymphocyte proliferation assays.

1. Before obtaining blood, anesthetize the mouse. Place six cotton balls into a wide mouth jar with a flat top. Under a fume hood, pipette 1.3 ml of Metofane onto the cotton and cover the jar with a watch glass. Place the mouse in the jar and remove the mouse when it has remained inactive for about 2 minutes.
2. Blood is obtained using the orbital sinus technique. Insert a heparinized capillary tube through the medial canthus of the conjunctiva and rotate the tube to sever the orbital sinus plexus. At least two or three tubes of blood should be collected from each mouse.
3. Blood-filled tubes are placed into EDTA-coated eppendorf tubes and blood is allowed to drain from the capillary tubes. Close the eppendorf tube and tap it gently to mix the blood with the EDTA to prevent clotting.
4. Cleanse the eye and fur of the mouse with sterile saline and return the mouse to its cage when awake.
5. Fill fresh heparinized capillary tubes with the collected blood and seal with sealing clay at one end. Spin the blood samples in a hematocrit centrifuge for 5 minutes. This will produce a serum layer, a white cell layer, and a red cell layer.
6. Etch the capillary tube with a file just above the white cell layer and gently break the top of the tube off at the etch mark. Insert the needle of a “tuberculin” syringe into the broken end of the tube and draw the white cells into the syringe.
7. Draw up 500ul of sterile phosphate-buffered saline containing 1% bovine serum albumin (PBS-1%BSA). This moves the cells through the needle and keeps the cells from clumping. Remove the needle and dispense the mixture into a 12 × 75 mm capped tube and add 10ul of red blood cell lytic agent. This will lyse any red blood cells that were drawn up into the syringe.

8. Gently invert the tube to mix and allow 2 minutes for the lytic agent to have full effect. Centrifuge at 1750 rpm for 5 minutes in a refrigerated tabletop centrifuge. Pour off the supernatant taking care not to disturb the thin film of cells on the bottom of the tube.
9. Add 1 ml of PBS-1%BSA to the tube and suspend the cells by shaking the tube gently. Centrifuge at 1750 rpm for 5 minutes in a refrigerated tabletop centrifuge.
10. Pour off the supernatant carefully and dab the final fluid droplets with a Kimwipe while the tube is inverted. Resuspend the cell pellet in an appropriate volume of isotonic solution for further analysis.

Simple Software to Demonstrate Changes in Allele Frequency

Susan M. Schenk

Joint Science Department, Claremont Colleges
925 N. Mills Ave, Claremont, CA 91711-5916
sschenk@jsd.claremont.edu

A fast, simple program was written in DOS (author: John Moeur) to allow our Introductory Biology students to simulate the effect of changes in population size, initial value of q , selection against different genotypes, and breeding ratio on the frequency of alleles in a population. The program includes genetic drift in all simulations and maintains a constant population size during each simulation. The students collect and graph the data needed to answer a set of standard questions and one of their own devising. The program is used in conjunction with a set of problems which require the students to calculate values for allele and genotype frequencies in populations which follow the Hardy-Weinberg model.

A Play For Genetics Lab

Roberta B. Williams

Department of Biological Sciences, University of Nevada, Las Vegas
Las Vegas, NV 89154-4004
(702)-895-3203, williams@nevada.edu

A number of years ago, GENESYSStems designed a teaching unit for freshman-level genetics entitled *Chances' Choices*. It is a fun, soap-opera story of the Chance family, a family that is plagued with genetic disorders. Nine genetic situations are dealt with (chromosomal, Mendelian, multi-factoral and sex-linked) in the story. Over the years, I have played around with this unit for my non-majors biology course. The lab instructors would present the story using overheads to explain the disorders and pedigrees to show inheritance. Some lab instructors could do a great job presenting the material, while others were dry and boring.

Two years ago I turned this soap-opera into a play. The students act out the parts of the Chance family and genetic counselor while the lab instructor gives background information between scenes. The lab sessions appear to more enjoyable now and hopefully, the students learn from the experience.

For the lab grade, each student must make a pedigree of the extended family and the genetic disorders. At the end of the play the students work in groups to discuss ethical issues that have arisen during the presentation. Each group hands in a written report of their responses to the discussion questions.

Kloza, Edward M. and Paula K. Haddow, 1988, *Chances' Choices*, GENESTStem, Scarborough, ME.

The Role of Biologists in Science Education of Elementary and Middle School Teachers

Ned Lyke

Department of Biological Sciences
California State University, Hayward

This mini-workshop was a roundtable discussion of a wide range of issues and resources in developing and improving courses directed at the science education of prospective and in-service elementary and middle school teachers. Faculty working with these students expressed a great need for emphasis on teaching scientific process rather than content, and that the faculty model for these new teachers the pedagogical approaches that attract and inspire our students. It was generally agreed that use of lecture formats that encourage a dialogue between students and faculty, investigative, hands-on, lab exercises, and collaborative and/or cooperative learning approaches were most needed in today's classrooms. The era of fact-laden lectures and recipe-driven laboratories needs to be brought to an end.

There is a serious need for a compilation of resources (course syllabi, lab manuals, discussion papers, sources of supplies and equipment, etc.) used by ABLE members and other college and university faculty. This listing of resources could be made available to interested faculty teaching credential candidate students university-level science courses. It was suggested that this perhaps could be done under the auspices of ABLE with a core group of members organizing the information and establishing a means (list-servers; e-mail; world-wide-web home page???) to make it broadly available.

A number of faculty around the continent already provide significant resources (time, energy, equipment, supplies, student interns, etc.) to their local K-12 teachers. These often imaginative and potentially far-reaching efforts are known only by a few colleagues. In addition, there are still many perceived barriers to interactions between faculty and K-12 teachers. Reluctance to overcome these barriers to cooperation and mutual support have been a major stumbling block to supportive liaisons between college/university faculty and teachers. A major advance would be greater efforts to break down these barriers.

There was general support for a suggestion made that the annual meeting of ABLE should routinely include a specific set-aside time for an extended workshop on these issues.

Chemotaxis in *Physarum*, a Plasmodial Slime Mold (a Simple Experiment to Teach Chi² Analysis)

Donna M. Bozzone

Department of Biology, St. Michael's College
Colchester, VT 05493
(802) 654-2627, bozzone@smcvax.smcvt.edu

Physarum polycephalum, a true or plasmodial slime mold (myxomycete) can exist in several distinct forms including fruiting bodies, plasmodia, and amoebae. The experiment described here studies the response of the plasmodium, a yellow slimy mass of indefinite morphology. Plasmodia are negatively phototactic and “crawl” to seek food. In nature, they are found under the bark of decaying trees feeding on microorganisms and organic material. A plasmodium can grow to a fairly large size (up to 30 cm in diameter; Sauer, 1982) and despite this large mass, it is not composed of separate cells but is one huge amoeba-like cell containing many nuclei (Sauer, 1982).

While many aspects of the behavior and physiology of *Physarum* plasmodia are quite intriguing, the protocol delineated below focusses on the chemotactic response of this organism. The exercise has several objectives:

1. Initial exploration of the phenomenon of chemotaxis in *Physarum* plasmodia.
2. Generation of testable questions about chemotaxis in *Physarum* and implementation of experiments.
3. Analysis of data using the chi² test.

Protocol

A. Chemotaxis Experiment

1. *Growing Physarum*. Preparing cultures of *Physarum* plasmodia is quite straightforward. You can obtain cultures from Carolina Biological (2700 York Rd., Burlington, NC 27215-3398) or other supply companies; order either the plasmodium or preferably, sclerotium stage (a resting structure; Catalogue #15-6190). Cultures are grown on sterile 1.5–2% non-nutrient agar (15–20 g agar per liter of distilled or deionized H₂O) with oatmeal sprinkled on top after the agar has solidified. Using a sterile scalpel, cut a block of agar on which a piece of plasmodium is present, and transfer it to the agar - oatmeal plate. If culturing a sclerotium, use sterile forceps to transfer a piece of filter paper containing the resting stage (this is how they arrive from Carolina Biological) to the agar-oatmeal plate. Wet the filter paper with a drop of sterile H₂O.

Once cultures are set up, seal the edges of each plate with parafilm, and wrap dishes in aluminum foil to keep out light. Cultures need to be transferred every 3–4 days if kept at

room temperature. However plasmodia will go into “suspended animation” for weeks (probably months) if refrigerated.

2. *Chemotaxis Assay*. There are a variety of ways to set up a chemotaxis assay for *Physarum* but to make this experiment suitable for χ^2 analysis, the plasmodium should be presented with two choices for directed migration.

Agar Block Method

- a. Each group needs a plasmodium culture, four non-nutrient agar plates (1.5–2% agar), one plate containing 1.5–2% agar in 100 mM glucose, and a scalpel.
- b. Cut blocks of agar from one non-nutrient agar plate and from the glucose-agar plate; these blocks should be approximately 1 cm².
- c. On each of three non-nutrient agar plates, deposit one agar block approximately 1 cm from the edge of the dish. On the opposite side of one of these plates, deposit a second agar block, also approximately 1 cm from the edge of the dish, and on two dishes, place a glucose-agar block. Be sure to mark the bottom of the petri dishes to indicate the identity of each type of agar block.
- d. Cut the plasmodium culture into 1 cm² blocks. Transfer an agar block containing a piece of plasmodium to each of the three petri dishes. Place the agar block, plasmodium side down, in the center of the dish.
- e. Wrap the dishes in aluminum foil and incubate at room temperature.
- f. Observe plasmodium migration at ~20–24 hours and record its location. A plasmodium positioned anywhere besides the center can be scored as a + for that half of the dish.
- g. We will pool class data.

Testing Food

Using the above method, you can test a variety of chemicals. To test foods, set up the assay as described above but instead of depositing a block of agar containing a test chemical, sprinkle a small amount of the test food opposite the agar block. Deposit the plasmodium in the middle, incubate in the dark, and record observations.

B. χ^2 Analysis of Sample Data

For this experiment, the null hypothesis is that plasmodia are not migrating directionally; migration is random.

Information about χ^2 analysis can be found in most General Biology or Genetics lab manuals (for example, see Eberhard, 1990). Tables 1 and 2 show the results and χ^2 values for several representative experiments.

Table 1. Chi² Analysis of Results of a Test of *Physarum* Plasmodium Migration in Response to 100 mM Glucose.

Migration	Observed (O)	Expected (E)	O-E	(O-E) ²	(O-E) ² /E
Moved Towards Glucose	14	7.5	6.5	42.25	5.63
Did Not Move Towards Glucose	1	7.5	-6.5	42.25	<u>5.63</u>
Null hypothesis is rejected			Chi ² = 11.27 degrees of freedom = 1 p < 0.01		

Table 2. Sample Results of Various *Physarum* Chemotaxis Tests.

<u>Test Substance</u>	Movement Towards Test <u>Substance</u>	Movement Not Towards Test <u>Substance</u>	<u>Chi²</u>	<u>p value</u>
100 mM glucose	14	1	11.3	< 0.01
50 mM glucose	11	4	3.3	< 0.10
10 mM glucose	12	2	7.1	< 0.01
2 mM glucose	12	5	2.9	0.10
oatmeal	20	0	20.0	<< 0.01
agar	8.5	7.5	0.06	0.80

Suggestions for Further Experiments

The references listed below provide lots of ideas for tests including various sugars, amino acids, vitamins, etc., at different concentrations and combinations. You also can test a variety of cereals, or other foods (I have tried Rice Krispies, Cheerios, Rice Chex, oatmeal, and Special K!). You can provide choices between attractants or combine attractants and repellents to see which response dominates.

References

- Carlile, M.J. 1970. Nutrition and chemotaxis in the myxomycete *Physarum polycephalum*: the effect of carbohydrates and the plasmodium. *J. Gen. Microbiol.*, 63: 221–226.
- Chet, J., A. Naveh, and Y. Henis. 1977. Chemotaxis of *Physarum polycephalum* towards carbohydrates, amino acids and nucleotides. *J. Gen. Microbiol.*, 102: 145–148.
- Eberhard, C. 1990. General biology laboratory manual. Saunders College Publishing. Fort Worth, Texas, 557 pages.
- Kincaid, R.L. and T.E. Mansour. 1978a. Measurement of chemotaxis in the slime mold *Physarum polycephalum*. *Exp. Cell Res.*, 116: 365–375.
- Kincaid, R.L. and T.E. Mansour. 1978b. Chemotaxis toward carbohydrates and amino acids in *Physarum polycephalum*. *Exp. Cell Res.*, 116: 377–385.
- Knowles, D.J.C. and M.J. Carlile. 1978. The chemotactic response of plasmodia of the myxomycete *Physarum polycephalum* to sugars and related compounds. *J. Gen. Microbiol.*, 108: 17–25.
- Sauer, H.W. 1982. Developmental biology of *Physarum*. Cambridge University Press. Cambridge, 237 pages.

Don't Say Math in a Biology Class

Laurie Iten

Biological Sciences, Purdue University
West Lafayette IN 47907
(317) 494-8113

We shared how we integrate more math and problem-solving into a biology core class we offer in the Department of Biological Sciences, Purdue University. This one semester course (Biol 131A) covers the development, structure and function of organisms. It's typically taken by first year biology majors. We handed out a portion of this class's syllabus that covers the basic mathematics first year biology students need for succeeding in this class. We also discussed how we help our students improve their problem-solving skills. The take-home message was: introduce more math and problem-solving into your biology classes; just, don't say math in a biology class.

Education and the Internet

Edward Andrews

Sir Wilfred Grenfell College
University Drive
Corner Brook, Newfoundland
Canada A2H 6P9
Tel: (709) 637-6471
Fax: (709) 639-8125
E-mail: eandrews@beothuk.swgc.mun.ca

In the last few years the word Internet and the phrase “Information Super Highway” have managed to creep into our vocabulary, yet the meaning of these “buzz words” is still unclear and the implications for education remain undefined. This workshop will attempt to identify the impact of student access to the Internet and attempt to outline some of the resources that can be utilized to provide enhanced learning opportunities for students. One local example of an education network (Stem-Net) that has blossomed from primitive beginnings will be the focus of this workshop. The development and impact of community and educational networking that will provide access to the Internet across Canada will be discussed. The audience may be called upon to share Internet experiences with other participants in order to expand existing knowledge of Internet resources.

Introducing Students to Scientific Literature*

Nora Ann Bennett

The Governor's School for Government and International Studies
4100 West Grace Street
Richmond, VA 23230
(804) 780-6155
Email: NABennett@aol.com

The goal of this activity is to provide first-year biology students with a structured introduction to the primary scientific literature. By directing students to specific articles, and guiding them through a critical reading of the article, it is intended that they will gain an understanding of and appreciation for this crucial aspect of scientific study.

Articles were selected for their straightforward experimental design and results, accessibility to introductory students with little scientific background, and moderate length. Instructors may want to select articles that directly relate to course content and/or touch on current events and recently announced findings.

Students in each lab section were divided into groups of four or five. During the first week of this exercise, each group was assigned a different article (the same articles were used for all lab sections). The articles were placed on reserve in the university library. When students arrived in lab the following week, each group was given a list of questions pertaining to its paper. These questions included items to check for basic comprehension of the article's content, and questions designed to require student analysis and evaluation of the paper's methodology and results. The students spent 45 minutes discussing the paper and answering the questions. Written answers were turned in for a grade.

Each group also received a list of generic questions, to be answered in the next portion of this exercise: the oral presentation. After the discussion, each group came to the front of the room and presented its paper. In most cases, each group member discussed a different portion of the paper. To encourage audience participation, each student was required to turn in a comment card or to ask a follow-up question during the presentations (this varied among the graduate assistants teaching the lab sections).

We found that, for this activity to be successful, students needed instruction in oral presentations. Otherwise, many presenters were unable to convey effectively the information in their paper. This activity probably should not be the first oral presentation in a class.

* Developed when the author was at the Department of Biology, College of William and Mary, Williamsburg, VA 23187

We found this activity a useful addition to our process-oriented lab curriculum. Students left with a greater understanding for this important, yet often overlooked, component of the process of scientific research.

For specific examples of journal articles and questions, please contact the author.

Using an Investigative Approach to Teach the Concepts of Fermentation*

*Arthur L. Buikema Jr.¹, Suzanne H. Braunschweig¹,
and Donna Harpold²*

¹Dept. of Biology, Virginia Polytechnic Institute and State University
Blacksburg, VA 24061-0406.

²Math and Natural Science Division, Virginia Western Community College.
Roanoke, VA 24038

Classically, the concepts of fermentation and respiration have been difficult to convey in a traditional laboratory setting. This is an investigative exercise which emphasizes hypothesis formation and experimental design; it requires incorporation of students' knowledge from both their lecture class and textbook. This lab can be completed in one 3-hour lab period or two 2-hour lab periods. Students are given the information that fermentation of wine ceases at a concentration of approximately 14% alcohol. Given a 2 hour lab scenario, students spend the first week of the lab exercise working in groups of 4–5 to form a hypothesis and to design an experiment for testing why this phenomenon occurs. Each group tests its hypothesis by carrying out the experiment the second week of lab. This lab provides an excellent opportunity for students to interpret real results obtained in the lab, to evaluate and refine experimental methods, and to communicate their findings either as a written lab report or an oral presentation.

* Development of this lab was supported by an SSI grant from the National Science Foundation under Cooperative Agreement #OSR 9250058 to V-QUEST.

The Use of Research, Teaching, or Personal Collections to Teach an Inquiry Based Introductory Biology Lab

Suzanne H. Braunschweig¹ and S. Llyn Sharp²

¹Dept of Biology, Virginia Polytechnic Institute and State University
Blacksburg, VA 24061-0406

²Virginia Museum of Natural History at VA Tech.
428 N. Main St., Blacksburg VA 24061-0542

University, or personal, specimen collections provide an often under-utilized teaching opportunity for introductory biology instructors. However, there are several advantages to using such collections: students can develop observational and inferential skills by studying morphological adaptation to habitat and niche specialization within a habitat; they can be exposed to extinct or endangered species and to the importance of preserving these species; students can learn to appreciate the role of a Museum as a teaching institution, and a place of active research.

In addition to the educational merits of using such materials, student interest is piqued by the “field trip” aspect of such a lab when going to a Museum, and by the chance to appreciate biological material in a “real world setting”. Finally, such a lab is a low cost endeavor; specimens can usually be easily obtained and protected from handling at very little cost to limited lab supply budgets.