

Bioscene

Journal of College Biology Teaching



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Bioscene

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University Biology Educators

Co-Editors:

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An archive of all publications of
the Association of College and
University Biology Educators
(ACUBE) can be found at
<http://acube.org>

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submit manuscripts by October
30, 1998 for consideration in the
next issue.



Cover Illustration: This
solitary hind foot track of a
raccoon, *Procyon lotor*, was
found in fast drying mud on the
northwestern shore of Lake
Tokorozawa in Macon County,
Illinois during the spring of 1995.
The image was scanned and
contrast enhanced by Ethel
Stanley.

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Bioscene: Journal of College Biology Teaching

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Please submit all manuscripts to either co-editor, Tim Mulkey or Ethel Stanley. We prefer receiving word processing files (Microsoft Word, Word Perfect, etc.) to facilitate distribution of your manuscript to reviewers and to make revisions as are necessary. If you wish to attach a file to email, please address the subject line as BIOSCENE. Your submission should also include the title, author(s), name of your institution with the address, a brief abstract (200 words or less), keywords, and references in appropriate format that are cited in the manuscript. Graphics are welcome! Graphic files may be submitted separately or embedded in the file. If you are unable to provide an image in an electronic format such as PICT for Macintosh or BMP for Windows, please include a clean, sharp paper copy for our use. Your manuscript will be sent to two reviewers as coordinated through the Editorial Board. You will receive suggestions and comments from the reviewers prior to publication of the article. Once accepted, your article will appear in the Bioscene and will be posted on the ACUBE website (<http://acube.org>). Authors retain copyright of their published materials.

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Suggestions for manuscripts include: announcements, book reviews, labs/field studies that work, course development, technological advice, software reviews, curricular innovation, history of biology, letters to the editor, undergraduate research opportunities, professional school, funding sources, current issues, etc.

Deadlines for Submissions

October 30, 1998 December 1998 Issue

February 28, 1999 April 1999 Issue

Effect of Soil Texture on Burrow Site Selection by Ground Squirrels

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Abstract: The distribution and abundance of organisms is determined by a variety of physical and biological factors. The purpose of this field-based, ecologically oriented laboratory experiment is to determine if the abundance of ground squirrel burrow sites is influenced by soil texture. Students are involved in all aspects of the experiment from the design to the collection, analysis, and interpretation of data. This laboratory exercise is easy-to-do, requires minimal equipment, and illustrates well the many facets of experimental design and implementation.

Keywords: soil texture, ground squirrels, burrow sites, experimental design

Introduction

The physical environment plays a major role in determining the distribution of populations of plants and animals. Preferences for and tolerances of environmental factors such as temperature, precipitation, and soil conditions vary among species and serve to restrict populations to habitats within which they are best adapted. Habitat structure and soil properties are major factors influencing selection of burrow sites by semi-fossorial rodents such as ground squirrels (Owings and Borchert, 1975; Murray and Vestal, 1979; Laundre and Appel, 1986).

Richardson's ground squirrel (*Spermophilus richardsonii*) is a semi-fossorial species whose distribution is influenced, in part, by soil texture. These animals exhibit a preference for drier, well-drained soils (Laundre and Appel, 1986) that presumably facilitate easy burrowing. Laundre and Appel (1986), however, also found that short vegetation, which allows for increased visibility, is preferred by ground squirrels. This latter characteristic makes this field experiment particularly appealing because 1) ground squirrels are fairly common on many college campuses (to the chagrin of the maintenance staff) due to their preference for short, mowed grass and 2) students can locate burrows fairly easily without having to walk through tall, thick vegetation.

This paper describes an easy-to-do, ecologically oriented laboratory experiment that demonstrates use of the scientific method in a field setting. Students will actively participate in the design of the experiment, collection, analysis, and interpretation of data. The specific objective of this experiment is to determine if

soil type influences the frequency of observed ground squirrel, burrow sites.

Methods and Materials

The instructor should obtain a soil survey map of the experimental area(s) in order to become acquainted with the variety of soil types present. The local Soil and Water Conservation District or Natural Resource Conservation Service offices will usually provide one upon request. A soils map is also valuable because it allows the instructor to direct the students' efforts to sites with known soil differences. In addition to finding plots with different soil types, the instructor will need to have the students preview the intended experimental areas for the presence of ground squirrel burrows.

After the experimental areas have been determined, the instructor can engage students in a discussion of experimental design. Some of the questions regarding experimental design that the instructor may present for student discussion include: Will the entire experimental area be surveyed for ground squirrel burrows or should students sample randomly from each of the experimental areas? Sampling may be preferred if the experimental area is very large, laboratory time constraints won't allow for a complete survey, or if ground squirrel burrows are particularly dense. If sampling randomly, how many samples should be taken and what should be the size of each sample site? I have found that taking three 10 x 50 M samples within a particular experimental area works well for a laboratory of 2 hours.

When the experimental areas have been identified, students and the instructor can then discuss how to collect ground squirrel and soil data as well as

design a data collection sheet for both variables. Burrow data may be obtained simply by walking through the experimental area and recording all ground squirrel burrows found within the boundaries of the area. Students should be cautioned not to confuse ground squirrel burrows with pocket gopher burrows. Ground squirrels generally leave the entrance to the burrow open (Quanstrom, 1971), whereas pocket gophers plug their burrow entrance with soil.

Within each experimental area, students may collect soil samples by inserting a soil corer approximately 30 cm into the ground, carefully withdrawing the corer and removing all vegetation from the top of the soil core, rolling off the top 20 cm into a plastic bag. They should label the bag with the name and/or number of the experimental area (or sampling site, if appropriate), date, and time. The instructor should have discussed with students the number of soil samples to take within each experimental area or each sampling site. I generally have students take three, randomly selected soil samples from each sample site.

When students return to the laboratory, they can determine soil texture for the areas sampled. Soil texture is determined by the proportion of clay, silt, and sand particles present (Smith, 1996). These particles are classified on the basis of size. Sand particles are largest (0.05-2.0 mm), followed by silt (0.002-0.05mm) and finally clay (less than 0.002 mm). The following procedure is relatively simple and based on the premise that different sized soil particles will settle at different rates.

1. In the lab, combine all soil samples for a given experimental area.
2. Mix the soil together thoroughly and pick out all the organic material.
3. Dry the soil by placing it in a drying oven set at 30 degrees C for 24 hours.
4. Remove the soil from the drying oven and weigh out 50 g.
5. Grind the soil with a mortar and pestle until it is of uniform consistency.
6. Transfer the soil sample to a pint-sized jar that has a uniformly flat bottom and a tightly fitting lid.
7. Fill the jar with distilled water to about 0.5 cm from the top.
8. Add one tablespoon of dry Calgon (to prevent soil from clumping) to the jar and shake vigorously.
9. Set the jar down on a flat surface and do not move it. Allow the contents of the jar to settle for 40 seconds. Have students measure the amount of sand (the largest, heaviest particles) that settled using a metric ruler and record it on a data sheet. Mark the sand line

on the glass jar with a wax pencil being careful not to disrupt the contents.

10. After approximately 2 hours measure the new band of particles, which represents the silt layer that has settled. Record the amount settled on the data sheet. Mark the silt line on the jar being careful not to disturb the contents.
11. After approximately 24 hours, measure the last band of clay particles that has settled and record on the data sheet.
12. When all the soil has settled, have students calculate the percentages of sand, silt, and clay in their sample. Using these percentages, have students determine the soil type of the experimental area by consulting a soil texture triangle (see Smith, 1996).

When soil type has been determined, students can summarize the burrow data for each experimental area. Burrow data can be compiled for all experimental areas with the same soil type. Students can then be instructed in the use of a chi-square goodness of fit test to compare burrow number with soil type. If experimental areas differed in size, or burrow data from two or more experimental areas were combined, the number of burrows observed for the chi-square test must be adjusted accordingly.

Results and Discussion

Do the results of the chi-square test support the hypothesis? In other words, is the frequency of ground squirrel burrows observed influenced significantly by soil type? This would be a good opportunity to discuss how the word "significant" differs among scientists and nonscientists. Nonscientists use the word "significant" if the results look intuitively different. To a scientist, however, the word significant implies that a statistical test has been done and the results obtained are not due to chance alone, but can be attributed to a specific factor. I have found that one of the most challenging aspects of this experiment, or for that matter any experiment, is helping students understand the use and meaning of statistical tests. Even students who have taken a statistics course still have difficulty understanding the importance of statistics in analyzing and interpreting data. However, I have found that a chi-square test is one of the easier statistical tests to explain to students.

If the results of the experiment are significant and soil type influences the frequency of ground squirrel burrows, does that mean that no other factors such as height of vegetation are important? Were all other factors, such as frequency of mowing the experimental areas, constant except for the one factor tested i.e., soil type? Was the test for soil testing appropriate and accurate? If more sophisticated laboratory equipment for determining soil type is available, such as a

hydrometer, more accurate soil data may be obtained. The method for determining soil type presented in this paper is simple, but may not be particularly accurate, especially if the soils in the area form a highly mosaic pattern. However, this exercise could be easily modified to incorporate more sophisticated soil analysis techniques. In this experiment, one assumes that ground squirrels exhibit a distinct preference for a certain soil type because it allows for easier burrowing. However, could there be another explanation? For example, soil texture has a great effect on the water- and oxygen-holding abilities of the soil, which in turn may have a considerable effect on the type of vegetation present. Do ground squirrels prefer certain soil types, or do they prefer certain vegetation as a food source, which is associated with specific soil types? How can data be collected differently to exclude this possibility?

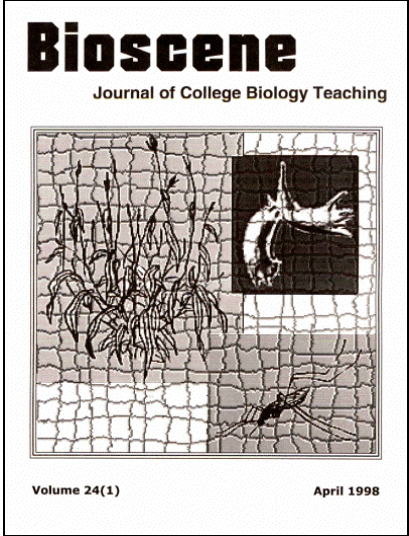
I often have my upper division ecology students use this laboratory experiment as the topic of a

scientific paper. The students are instructed to write the paper as if they plan to submit it to a respectable, ecologically oriented journal. For lower division courses, this laboratory experiment can be modified so students don't write a paper, but write answers to the questions posed above or give an oral presentation of the results to the rest of the class.

In conclusion, this field-based laboratory experiment is relatively easy-to-do and generally enjoyed by students, even those onto ecologically oriented, because of its out-of-doors focus. This experiment also presents an excellent opportunity for the instructor to discuss the many facets of experimental design as well as the inherent difficulties in controlling variables, with the exception of the one being tested, in a field setting.

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Do you have a manuscript, announcement, book review, labs/field studies that work, course development materials, technological advice, software reviews, curricular innovation, letter to the editor, or undergraduate research opportunity to share?

Publish your work in **Bioscene**. We prefer receiving word processing files (Microsoft Word, Word Perfect, etc.) to facilitate distribution of your manuscript to reviewers and to make revisions as necessary. If you wish to attach a file to email, please address the subject line as **Bioscene**. Your submission should also include the title, author(s), name of your institution with the address, a brief abstract (200 words or less), keywords, and references in appropriate format that are cited in the manuscript.

Please note that the deadline for the December issue is October 30, 1998. The deadline for the April 1999 issue is February 28, 1999.

Association of College and University Biology Educators 42nd Annual Meeting



October 15-17, 1998
Rockhurst College

"Are We Preparing Global Citizens: Aware, Active, and Accountable?"

FINAL CALL FOR PRESENTATIONS, POSTERS AND EXHIBITS

Biology faculty and their students are invited to share:

- field and laboratory exercises developed for your courses
- software currently used in your courses or under your development
- posters featuring research in biology or science education

Field or Laboratory Exercises:

The title, author, and a brief description of the exercise must be submitted by **October 2, 1998** to the program director. Each presenter should bring 50 copies of the exercise to distribute. A table will be set up in Room 206 of Richardson Science Center for these copies. A disk copy of the exercise in a standard word processing format or text file would be appreciated as well. These exercises will be entered into an ACUBE file that can be accessed electronically. The steering committee wishes to rebuild the field/laboratory exercises archive to maintain for distribution.

Software:

The title, author, platform (Mac/PC), and a short summary of the use of the program must be submitted by **October 2, 1998** to the program director. Mac and PC computers will be provided in Room 203 and 205

of Richardson Science Center for display/investigative use of the program. Freeware, shareware, and individual software developed by the presenter who wishes to distribute copies must be clearly labeled "For Distribution", otherwise no copying of software is permitted.

Posters:

The title, author(s), and a short abstract of the poster content must be submitted to the program director by **October 2, 1998**. This information will appear in the final program and be published in the *Bioscene* after the meeting. Posters will remain on display for the entire meeting in the main entranceway (Richardson 'Street') of Richardson Science Center. Poster stands will be provided. Ask at registration desk

ALL submissions are greatly appreciated!

Please use the Abstract Form on the web (<http://acube.org>) for your submission(s) or make your submission by e-mail: Terry.derting@murraystate.edu

Using the Internet to Enhance Biology Education: Suggestions for the Novice

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Abstract: This paper provides examples of Internet resources, specifically email and world-wide web uses, in undergraduate biology courses. Educators find both challenges and opportunities as new technological tools become available. Both pitfalls and valuable practices for students in computer-enhanced courses are emphasized. Faculty who wish to learn more about using email and web resources in their courses will find examples of activities and accessible web pages that reflect the author's approach to solving some of the dilemmas of the internet's unrestricted world-wide communication and access. The Internet offers "an infinitely expanding classroom" for perceptive and prepared faculty and students.

Keywords: internet, web pages, email, listserv, educational technology, teaching strategies, biology education, emerging diseases, pedagogy

New technologies bring with them opportunities and challenges. Educators are faced with the challenge of using email and the Internet, as well as other computer technologies to improve pedagogy. Email and the Internet provide increased communication and access to information, but additionally can provide opportunities to vastly expand the scope of the classroom and the textbook. The challenge for educators is to explore how can we use these tools to open the educational process in our classrooms and labs.

More and more students arrive on campus with computers of their own and with some experience on the Internet. In 1997, sixty-percent of new Beloit College students arrived with computers. Students have learned word processing at high school and may have subscribed to America on Line or another Web browser. Some have skills that far surpass those of most of their professors, while others are only typists.

While many of the students arrive on our campuses with experience playing or shopping on the Internet, few have used it for serious research. As they begin to do research and probe primary sources at college, we face the challenge of integrating their web skills and their research skills into a coherent approach.

At the same time faculty are exploring the potential of the Internet to enhance student learning. Campuses are linked to the Internet, but often faculty are left alone to discover the best use of these resources. The aim of this article is to provide teachers with an introduction to the potentials and the problems of using the Internet in the college biology classroom. We will explore the uses of email, the potentials and

pitfalls of "library research" and then look at some of the potential new areas for use of technology in the classroom and the lab.

EMAIL. Email is the first introduction to electronic communication, and one which most faculty have adopted. Email can be used to increase communication with students on campus and off, and to extend the reach of classroom discussion. The simplest use of email is to construct a class list and use it as a bulletin board, to modify assignments and clarify questions raised in class. The email software Eudora allows users to set up a "Nickname" which can send mail to all students listed. Through email communications, faculty can provide students with guidance on reading difficult materials, such as journal articles or help structure study.



The email message below was sent to guide non-majors in reading an article by Joshua Lederberg, "Infectious Disease as an Evolutionary Paradigm" which was published in *Emerging Infectious Diseases*, Spring 1998.

Email can also serve as a conduit for student journals about their experiences and about class process and class progress. In this way it can provide students with the chance to give feedback to the instructor and to participate in the construction of course flow. Students comfortably communicating

Dear Emerging Diseases class-

1) If you didn't get the article, "Infectious Disease as an Evolutionary Paradigm" today, there are copies outside my office in an envelope.

2) This article isn't as hard as it seems. Remember, however, that it was written for health professionals not college students. Read it slowly and remember that evolution is a process of genetic mutation and recombination.

Epitopes are variations in antigens.

On page 421, Lederberg talks about "clonal selection model of immunogenesis". I know that this is a confusing phrase. It refers to the process we discussed in class, that when T cells or B cells encounter an unknown antigen, they recombine genes that produce the different shapes of the Y type receptors, until the random recombination results in a Y type receptor which fits the new antigen. Then this new T cell or B cell is cloned, so that there are lots more cells with receptors that fit. So this is the clonal selection model of immunogenesis. You know more than you thought you did.

In the next paragraph, Lederberg talks about "hemopoetic modifications that thwart the plasmodia"; here he's referring to changes in hemoglobin structure that result in conditions such as sickle cell anemia, which he refers to as modifications in Hemoglobin S. The plasmodium is the parasite which causes malaria. Can we change receptivity to disease by gene therapy? Its an interesting question. Recently scientists discovered a group of men with a mutation in a cytokine producing gene which seems to block HIV from establishing an infection.

Look carefully at tables 3, 4, 5. There's a tremendous amount of information stuffed in these tables. When Lederberg talks about "promiscuous recombination" in table 3, he is referring to the ability of bacteria and viruses and yeasts to exchange bits of genetic information called plasmids across species. This is very important in the exchange of virulence factors- those instructions to the bacteria or virus to produce toxins and enzymes which make the disease more harmful.

OK. I don't want to write as much as Lederberg. Please come to class on Monday with a question about this article...and use a dictionary if you need one.

Have a great weekend.

with their professor on email can ask for clarification or ask for the classroom pace to be slowed. This process of communication and modification gives students an increased stake in their own learning.

A more sophisticated use of the email is to create a class listserv for discussion. A listserv needs to be set up in consultation with the campus computer service office. In contrast to email, in which all communication is routed through the professor, a listserv becomes the property of all students and is a more egalitarian forum for class discussion. Care of the listserv can be rotated among students in the class. An example of listserv use would be to stimulate discussion about a controversial reading or item in the news; a class on Environmental Biology might discuss recent newspaper articles on the fires in Florida and their environmental impact. Student moderators make sure that the discussion continues by providing probing questions, and keeping responses on track. Students can be required to participate and be evaluated on their comments. A listserv also provides a way to answer questions in large settings so that all students benefit.

Uses of the Internet and the World Wide Web

The Internet opens tremendous opportunities for student research from raw data, primary papers and secondary sources. Collections of visual images, movies and animations can expand opportunities for visual learning. The Internet is like a huge library that continually adds new resources, but it also is like the corner newsstands, filled with muckraking and half-truths. One of the challenges for faculty is to guide student use of the Internet to maximize learning and minimize the risks of stumbling down blind alleys, believing iconoclasts, and falling prey to commercial ventures.

A. Copying. The Internet provides continually growing sources for research, but may also be abused by students seeking an easy way to fulfill class needs. This section discusses plagiarism as well as creative uses for Internet research.

The most problematic use of the Internet is for access to prewritten term papers. All faculty should be aware of this new resource that supplants fraternity files and locally available commercially written papers. Sites such as <http://www.schoolsucks.com> provide term papers on many subjects and links to others sites that offer to do research for a fee. Biology papers easily found on "School Sucks" include essays on Marfan's syndrome, Mitochondria and Chloroplasts, and Eukaryotic Organelles.

Faculty can limit the use of prewritten papers by providing writing assignments that are specific to class discussion topics or specific readings or which ask students to explore a new perspective. The simple assignment to "write about a genetic disease" may be easily fulfilled by papers found on the Internet, while

the assignment, "Write a letter to your grandmother explaining the genetic disease "x" which your cousin was just diagnosed with" is harder to copy directly and probably results in better work as well.

Students may also "borrow" sections of papers from the Internet. While the sources of these are difficult to trace, they are easy to detect because of differences in writing style and use of vocabulary. Students need to learn how to quote and reference Internet sources in order to integrate them into research reports.

B. Enhancement of Class Presentations. Class presentations can be enhanced with video and visuals from the web. Faculty have access to easily projectable images from sites like Cells Alive (<http://www.cellsalive.com>), the Bock Laboratory of Virology at University of Wisconsin and many more on line collections of images. Cells Alive has video clips of *E. coli* multiplying, and enhanced micrographs of macrophages engulfing bacteria. The CDC has on line slide sets on epidemiology of Hepatitis, of AIDS, and tuberculosis, among others. The quality of these images enhances classroom presentation, and introduces students to the resources that researchers and professionals use. The use of these pictures and others can model resources on the Internet and can be a starting point for student research and presentation. By using these materials in class, faculty communicate to students that they have accessed sophisticated resources and can use them themselves. In my classroom, I showed one student how to do an Internet presentation, and the other students observed and were able to develop their own presentations.

C. Student Research - Unguided. Faculty can ask students to use the Internet for research, but without guidelines, it is wasted time. Recommendations to use primary sources are forgotten as "great" sites are discovered. Students find authoritative reviews mixed in with lecture notes and warnings of gloom and doom from random authors. Or, alternatively, students do a poorly directed search and end up with non-specific findings. Consequently, the quality of information is varied, and students may waste a lot of time. I find that unguided research on the Internet is only valuable as an example of how not to do things.

D. Student Research - Guided. Faculty can improve the Internet experience for students by advanced planning and guidance. The research experience improves if students develop guidelines to judge quality, if they use the web to contrast varying opinions on topics of interest and if they are introduced to internet sites of links developed for research in the field they are exploring. These introductory exercises

help bridge the transition from Internet for shopping and play to Internet for scholarship.

1. Quality. One approach to introduce students to the variable quality of the web as to provide students with a questionable but respectable looking web page and ask them to evaluate it. One of my favorites was a news release on a research study entitled, "Chocolate doesn't increase cholesterol levels." The article appeared credible (sadly it is no longer posted on the Internet) but its address revealed that it had been posted by the Candy Organization of America. A little probing on their web site brought the reader to the visions of sugarplums that highlighted their page. Students here could also critique study design and ask about study sponsorship. Students also note on this page that there are no references. One might also conclude that the research was done at the Pennsylvania State College of Medicine in Hershey, Pa.

Although this page is no longer accessible, others of similar quality and commercial sponsorship exist.

Another way to introduce students to evaluating the quality of Internet resources is with a specific assignment that contrasts different approaches to the same topic. An example of this can be found on <http://www.beloit.edu/~biology/evaluate.html>. (see Figure 1) This page was prepared for a class on emerging diseases, and it illustrates the problems of reading articles without looking at the sponsors. These articles are quite convincing, but they seem to say different things. Students are challenged to look at who the writers are and what their biases are. They can also be asked to evaluate the scientific credibility of the work they are reviewing. Does it clearly annotate references? Are the references from reputable journals? What are the credentials of the authors or the sponsors?

The activity above can also demonstrate the results of using different search terms in finding scientifically credible resources. This exercise uses articles found by searching for "vaccination" articles. A search on "vaccination" yields substantially different results than one on "immunization", which is still different from "pediatric immunization." "Vaccination" finds articles advising parents to avoid immunizations, while "immunization" finds scientifically recommended practices and medical research.

From Microbiology, a topic that raises controversies is the irradiation of food to retard bacterial growth. Students can learn to do a search by typing in "food irradiation". Articles are posted from university sources, the American Dietetic Association, and several anti-nuclear groups. Students then need to judge not only the content quality of the articles they read, but also the source of the information. This reading can become the basis for a critical thinking activity.

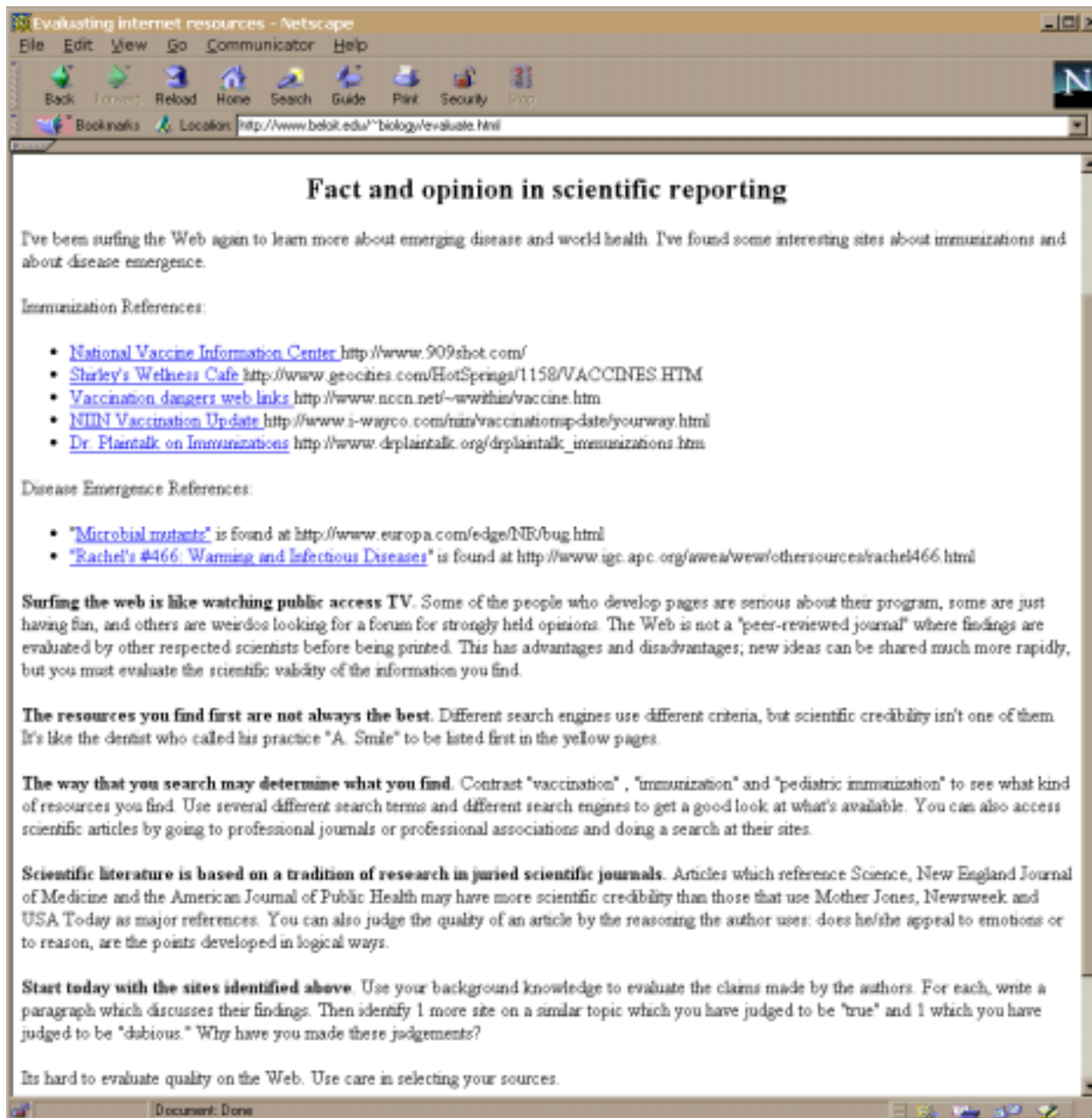


Figure 1. Web page used to introduce students to Internet resources.

2. Guidance. Guidance in developing a list of acceptable web sites or links to online journals may help students structure their Internet based research through reputable sites. Many professional groups have set up lists of related web sites. The American Society for Microbiology home page has links to a wide range of scientific sources at <http://www.asmusa.org/others.htm>. The Centers for Disease Control Office of Emerging Infectious Diseases lists resources at http://www.cdc.gov/ncidod/id_links.htm. The reference list prepared by the Partnership for Food Safety Education at

<http://www.fightbac.org/links/index.html> has an excellent set of references on food safety. The pre-research planning by the faculty member, both identifying specific sites and on line bibliographies will increase the profitability of student research and decrease student frustration. It also allows the teacher to outline acceptable and dubious websites and to prepare a format for citation. I find that web research should be cited in standard bibliographic format, with the web address (URL) and date of contact listed at the end. Students may need guidance to learn to identify

the author on many web pages, especially those from professional organizations.

3. Expanding activities Internet research can be constructed to form an open ended textbook for many science classes. Hot links to strong visual representation of micrographs, molecular visualizations, and other biological images and interesting web sites allow students freedom to explore while increasing their understanding of the topics. I have used web sites with photomicrographs and visualizations of virus structure to complement the first session using microscopes in Microbiology (<http://www.beloit.edu/~biology/microscope.html>).

This web search expands the students' visual understanding of the bacteria and protozoa that were just dots under the microscope. Assignments that provide access to various web sites introduce students to the potential of the Internet for scientific research. In a class on Emerging Diseases, I gave students three references on the Bubonic Plague to review, and then asked them to find and review two additional internet references on their own. This was preparation for further research on diseases of their own choice. (see <http://www.beloit.edu/~biology/activities.html> for this activity.) Remember, however, that students often don't have time to explore the best-designed web sites unless they have an assignment that encourages them to be there.



Figure 2. Hotlinks are provided to sites containing biological images.

E. Student research with web based scientific tools. The most exciting possibilities for use of the Internet are with professional data sets that are shared. Online Mendelian Inheritance in Man, the Weizman Institute Database <http://bioinformatics.weizmann.ac.il/cards/> and other on-line databases that allow students access to scientific data are examples. The Virtual Fly and the Visible Human are further examples of available material which provides data for classroom use. Class projects need to be created to have "real" value, but students can interact with real data rather than simulations.

F. Construction of web pages, based on all of the above. Students can publish class papers and projects on-line, using "What you see is what you get" programs like Pagemill, and with templates for papers. This activity provides an introduction to web credibility and to responsible research and reporting. Faculty needs to be aware of responsibilities to the academic community for accuracy and for protection of copyright as students prepare pages for publication beyond the university to the "universe." One faculty member was made painfully aware of this when a student completed a paper on a tropical disease and published it on the class web page, linked to the Biology web page and the University web page. Within two weeks the professor was contacted by a researcher from the World Health Organization who objected to his information being used on the web page without appropriate quotes or citation, and who threatened to contact the Trustees of the University.

Students can easily "borrow" text or images from other web sites to enhance their web pages. These certainly increase both the visual appeal and the intellectual challenge of these pages, but images should not be used without explicit permission of the site sponsor. Some of these images are copyrighted, and others are "sold." Often site sponsors are happy to have their site linked to the student page, but not to have their images used directly. The issues of intellectual property are still in discussion, but it's important to try to be as legal as possible.

Faculty will find that students readily adopt web-publishing tools, and may enhance their pages in sophisticated ways. A quick introduction to web page construction may be enough for most of the students. Faculty who lack expertise need only to find a helpful student to enhance the learning of the others. See web pages developed by non-majors at Beloit College at <http://www.beloit.edu/~biology/healthdis.html>.

Students who prepared their own web pages expressed a greater appreciation of the value of Internet communication, and a greater skepticism about the credibility of web resources. They had only to realize the ease with which they became Internet authors to see that everything on the Internet isn't "the truth."

Conclusion

The use of email and the Internet provide great opportunities for students to improve communication with faculty, to enhance library research skills and to use real data in generating questions for further study. Although diving into cyberspace may seem daunting to

the novice, preparation by faculty can greatly enhance student research experiences. It is our challenge to use the Internet as an infinitely, expanding classroom, rather than a "quick and dirty" substitute for real study.

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ACUBE 42nd Annual Meeting

Rockhurst College
Kansas City, Missouri
October 15-17, 1998



Are We Preparing Global Citizens: Aware, Active, and Accountable?



Sharon Anthony, Anita Salem, Louise Liao, and Pres Martin in a ChemLinks workshop at the 1997 meeting.

Commonalities in Biology

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Abstract: Ernest L. Boyer has proposed the incorporation of what he calls the seven human commonalities into college courses. He believes that by doing so students will become less parochial and more global individuals. For the past two years, I have applied his commonalities approach to both a General Education course and an introductory course for biology majors. The commonalities have been presented in a student-oriented discussion format. Preliminary results based upon class participation, short essay exam questions, and the ability of the students to detect these commonalities in a wide range of organisms suggest that this format is a valuable teaching technique..

Keywords: Commonalities, discussions, global biology, student participation, teaching tools

Starting each semester with hope springing eternally in my breast and ending each semester with the discouraging realization that I have not reached many of the students and have failed to communicate to them the excitement and relevance of Life Sciences, I continue to invent or “borrow” new approaches to achieve the impossible task of turning every student into a biology major or at least into an individual with an increased appreciation for the value of biological knowledge. To this end, I attended seminars and workshops at our Center for Teaching and Learning; perused the Weekly Teaching Tips provided by the Center; attended a Sigma Xi presentation by Craig Nelson on the improvement of teaching; read a variety of publications, journals and books, on the subject; and talk with other faculty and students. In other words, I continue to try. Prior to the start of the 1997 Spring Semester, I came across a report by Ernest L. Boyer in *Rethinking the Curriculum* entitled “Making the Connections: The Search for Our Common Humanity”. He states:

“Today’s students live in a world that is economically, politically, and environmentally connected. Our shorelines are polluted, and the tropical rain forests are being destroyed at the rate of 100,000 square kilometers every year. I worry that education in this country is becoming increasingly parochial at the very moment that the human agenda is more global. Students are not becoming sufficiently well-educated about the world they will inherit.”

He states that an undergraduate curriculum should be based on what he calls the *human commonalities* — those universal human experiences that are found among all people and all cultures on the planet. He then proposes the question “What are these experiences that ‘non-uniform people’ have in common?” He lists seven commonalities.

Human Commonalities

1. We all experience life. All experience birth, growth, and death.
2. We all communicate with each other.
3. We all respond to the aesthetic.
4. There is an historic perspective; we all recall the past and anticipate the future.
5. We all organize ourselves into societies.
6. We all are embedded in Nature. We are interconnected.
7. We all seek to give meaning to our lives.

Starting in the spring semester, 1997 and continuing through the 1997-1998 academic year, I have attempted to apply these “commonalities” to the material covered in both an Introductory Biology course for majors and a Human Aspects of Biology course for general education students. I have presented these commonalities in the form of discussion questions along with other discussion questions contiguous with each topic covered.

Two days prior to each class period I provide the students with a relatively complete outline of the material to be covered and a set of discussion questions with commonality questions included. Normally we spend 25-35 minutes going over the material in the outline and then spend the rest of the 50 minute period discussing the questions. As anyone who teaches a General Education course or a freshman, Introductory Biology course for majors knows, the students don't enter the class eager to engage in discussions of a biological nature. Therefore, it usually takes about three weeks to encourage, trick, bribe, or threaten many of the students to play an active role in the class. In one particularly "difficult" General Education class in which the sound of participating voices wouldn't have muffled the sound of a pin dropping, I casually mentioned that a particular question would be included on the next test, and I felt confident that it was so easy we didn't need to discuss it. The metamorphose was rapid, amazing, and satisfying.

Hands were raised to object to my cavalier dismissal of the necessity to discuss the question and voices offered possible answers. During succeeding class periods, there was no shortage of student participation in considering the discussion questions. But regardless of the technique one employs to encourage participation, the objective is to help the students realize that their participation is encouraged to help them understand the material and perform better on the tests, not to provide another obstacle to their spending a nice, silent, comfortable 50 minutes in class.

Although it is somewhat more difficult to include the concept of Boyer's commonalities in a General Introductory Biology course than in a course stressing human aspects of biology, with the exception of numbers one and three it can be accomplished. Examples of the discussion questions utilized for certain topics in each course will provide an idea of the way this can be done.

HUMAN ASPECTS OF BIOLOGY—GENERAL EDUCATION COURSE

Topic	Questions
Introduction	<ul style="list-style-type: none"> • How does recycling of physical materials demonstrate that humans are embedded in nature, that all organisms are interconnected? • How does the concept of "Spaceship Earth" imply that all humans are interconnected and that we all communicate with each other?
The Cycling of Nutrients	<ul style="list-style-type: none"> • Relate the carbon dioxide levels in the atmosphere to the past and to the future. • How do the two types of biogeochemical cycles demonstrate the interconnected aspect of humans and the communication that occurs between them?
Human ecology	<ul style="list-style-type: none"> • Connected to the concept that we all seek to give meaning to our lives, what is one of the major ways that we measure the success of an individual in the United States? • Compare this with the way we measure success of an individual plant or animal in a natural ecosystem. • All organisms experience birth, growth and death. Relate the factor of pollution to these stages of life.
Population	<ul style="list-style-type: none"> • We all experience life and we all have a historic perspective. Relate these to the significant differences in the average life expectancies in various regions of the world.
Fertilization & Development	<ul style="list-style-type: none"> • Is there any communication between the early embryo and the mother? • How does one person giving birth to a child impact society in general? • Is there any evidence that the developing embryo organizes itself into societies? Explain.
Aging	<ul style="list-style-type: none"> • We all experience life, but has technology encouraged us to think differently (non-traditionally) about both life and death? • What social and economic changes will be required as the number of individuals over 65 increases? • We all seek to give meaning to our lives. Are the quality and quantity of life important aspects of this meaning?
Cancer	<ul style="list-style-type: none"> • Does cancer violate the concept that we all experience birth, growth, and death? Explain.
STDs	<ul style="list-style-type: none"> • What evidence do we have that HIV communicates with cells in the human body? Is there any evidence of an historical perspective in this relationship? Explain.

**LIFE SCIENCES 101 -- INTRODUCTORY COURSE FOR
LIFE SCIENCE MAJOR AND MINORS**

Topic	Questions
Bacteria	<ul style="list-style-type: none"> • Discuss the history of the use of bacteria to process certain types of food. • How is <u>E. coli</u> interconnected to human beings?
Protista	<ul style="list-style-type: none"> • How does the relationship between a parasite and its host indicate a historical perspective and a type of communication?
Fungi	<ul style="list-style-type: none"> • How are fungi interconnected with humans? • It is said that humans organize themselves into societies. Is there any evidence that fungi do the same? Explain. • Is there any historic perspective in the relationship of fungi and humans?
Mosses and Ferns	<ul style="list-style-type: none"> • Is there any evidence of communication between moss plants? Explain. • Is there evidence of a historical perspective to ferns? Explain
Angiosperms	<ul style="list-style-type: none"> • Give examples of how flowering plants are embedded in nature. • How does our use of flowering plants give evidence that we respond to the aesthetic?
Plant Growth & Development	<ul style="list-style-type: none"> • What is the communicating messenger in the case of seed germination? • What is the reason(s) that all cells don't receive or respond to the same messenger in the case of plant hormones?
Plant Structure	<ul style="list-style-type: none"> • Relate birth, growth and death to a xylem vessel.
Tour of the Cell	<ul style="list-style-type: none"> • Give evidence that organelles within the cell are interconnected. • Trace the birth of a protein; include involved structures

**LIFE SCIENCES 102 -- INTRODUCTORY COURSE FOR
LIFE SCIENCE MAJORS AND MINORS**

Topic	Questions
Evolution of Animal Body Plan	<ul style="list-style-type: none"> • Are cells able to communicate with each other? Give evidence of this from the material covered today. • Is there any evidence of history in this material? Give examples. Suggest where this history is written. • When a cell becomes a tissue, what changes occur in its functions? • Compare this to a human being becoming a member of society.
Classification of Animals	<ul style="list-style-type: none"> • Is there a historical perspective to the different phyla of animals? Explain. • In order to add a little aesthetic value to your study of the phylogenetic tree, make a sketch of the tree with each phylum represented by an ornament which depicts the structure, shape, and gross anatomy of an organism representing each phylum.
Platyhelminthes	<ul style="list-style-type: none"> • What evidence is there that parasitic flatworms communicate with their host and have an historical relationship with the host?
Annelida	<ul style="list-style-type: none"> • In what ways are earthworms interconnected to humans?
Insecta	<ul style="list-style-type: none"> • Do insects belong to societies? Explain.
Mammalia	<ul style="list-style-type: none"> • How does the placenta suggest cooperation between humans? • How do parents communicate with offspring prior to and after birth?
Genetic Material	<ul style="list-style-type: none"> • What are some of the ways that a parent communicates with its offspring?
Vertebrate Development	<ul style="list-style-type: none"> • The development of the amphioxus embryo and the frog embryo appears to be very different. What evidence is there of historical connection? • Do cells of a developing embryo arrange themselves in societies?

EVALUATION

A faculty member at Indiana State University provided an interesting insight into evaluating a new program or method. She said that in China, teachers conduct an educational experiment for a minimum of three years before they attempt to evaluate it. She further stated that after one semester or one year, an evaluation merely examines an adjustment period. I hope the major benefit of this experiment will become apparent during the students' upper division biology courses that occur largely in the junior and senior years. However, being an impatient faculty member not in China, I have attempted at the end of each semester to evaluate the affect of the commonalities approach with its increase in class discussion.

One affect is the performance of the students on short, discussion questions on the exams. Prior to changing the class format, students did poorly on discussion questions. In fact, a significant percentage would answer the objective questions and omit many of the discussion questions. Now by the second or third exam, the average grade for the discussion questions is better than for the objective questions.

Another affect is that students play a much more active role in the learning process. Answers to discussion questions are often handled by a row of students. This not only takes the onus off an individual student but also allows the students to test their answers in a small group before presenting them to the whole class. After three semesters of utilizing the discussion approach, the students now enter class knowing that they are expected to help educate each other. This involvement has continued into succeeding courses. Students who completed L. Sci. 102 in the spring of 1997 have now completed two other biology courses. Faculty in these courses have informed me that the students have continued to participate in class much more than students in the past.

An evaluation of the commonalities approach suggests several additional outcomes. The students become aware that all organisms communicate within the individual organism and between organisms. They realize that most communications are done by chemical molecules. As the semester progresses, they realize that whenever organisms interact or there is an action within an organism there must be communication signals. The ideas that all organisms are interconnected, that we as humans are directly or indirectly affected by most other organisms, that we in turn have an effect on most other organisms surface relatively early in the semester. Students also learn that only humans keep written history records, but all organisms, including humans, keep their history in their genetic material; and that a systematic development of an organism requires a precise set of records or evolutionary history.

Using the commonality "All experience birth, growth, and death", which can be demonstrated in a wide range of structures from molecules through cells to whole organisms, I find it interesting to observe the students determining when and where molecules are "born, live, and die." The students have an interesting time learning that an enzyme molecule is "born" at the ribosome, modified in the Golgi complex, lives for a relatively short period of time during which it catalyzes a specific reaction, and then at some point, difficult to determine, is degraded, "dies." There is little unanimity when the students consider when an amoebae is born; some suggest this occurs just after its predecessor underwent fission, but others argue that its birth goes way back. Determination of its time of death is not easy for the students to agree upon. Did it die when it underwent fission or does it continue to live because a part of it makes up each of the two resulting amoebae? Does it continue to live in each succeeding generation? Does it live forever or is there a point at which none of the original organism exists? Some of the students argue that multicellular organisms, that give rise to offspring, do not die as part of them continues to live on.



The importance of these discussions lies not in arriving at a "correct" answer but in the thinking required to consider the question. Based upon the definition of a tissue as a group of like cells performing a specific function, the students recognize that a grouping of individual cells or organisms forms a type of society; and the different types of cells and tissues constituting an organism function as a complex society. Using the term "society" "in a broad sense, all multicellular organisms encompass many different societies. Organisms in turn are organized within certain social groups, i.e. Hymenoptera demonstrate a high level of social organization.



By seeking the commonalities in each group of organisms, the student can see threads that are woven through all living organisms. It is easier for them to learn general concepts that organisms have in common rather than a great number of specific details indicating differences between organisms. It is hoped that they will retain general concepts for a longer period than they do specific details; studies have shown that major percentage of specific details are lost in less than a year.

The commonalities and increased class discussion approach impacts teaching as well. I enjoy

the class a lot more. The students often contribute suggestions and ideas about the material that are humorous yet original and thoughtful. I teach two sections of the same course during the fall semester. Whereas in the past the second section was repetitive and somewhat boring for me, now each section is a unique experience because the students and their ideas are unique. Student involvement is something most teachers desire, and this approach certainly achieves

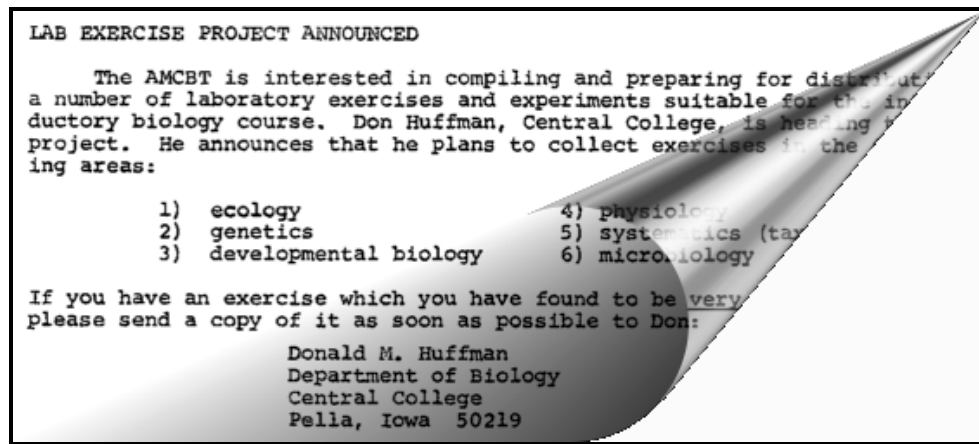
this. Dealing with the concept of commonalities has required me to view things differently and I have learned as much or more than the students. In a television advertisement for a food product two children were undecided whether or not to eat it; they gave it to a younger child. As the child ate the food, the look on his face indicated it was good, and the other two children remarked "Mikey likes it." In regards to the commonalities approach "Bill likes it."

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Let's take a Page from AMCBT History!



Volume 4, Issue 1 (June 1967) Lab Exercise Project is announced to members.

Wanted: Lab, Field, and Computer Activities

You are invited to share lab, field, and computer activities that you have developed for your own courses. If you have an exercise or project that works well for your students, consider publishing this activity in the Bioscene. These activities immediately become resources for the ACUBE membership and the extended **Bioscene** readership. Please plan to include images or lists of materials that would provide additional support to others planning to use your activity!



MY, HOW WE ARE GROWING!



AMCBT THEN --

At the first meeting in 1957, there were 44 members from 11 states



ACUBE NOW --

As of August 1998, there are 340 members from 30 states

Note: You can see where we need to recruit. Help ACUBE as well as your colleagues by letting them know of the benefits of *your* organization.





ACUBE 42nd Annual Meeting

Rockhurst College
 Kansas City, Missouri
 October 15-17, 1998

Preliminary Program

Are We Preparing Global Citizens: Aware, Active, and Accountable?

Thursday, October 15th

6:00 - 8:00 PM	Registration and Reception	Richardson Entrance
8:00 PM	Opening Session Welcome for ACUBE ACUBE President: Karen Klyczek , <i>UW-River Falls</i> Welcome to Rockhurst College: Corey Simmonds , <i>Acting Dean,</i> <i>College of Arts and Sciences</i> Program Chair: Terry Derting , <i>Murray State University</i> Local Arrangements Chair: Kevin Williams and Dick Wilson , <i>Rockhurst College</i>	Richardson 115
	OPENING ADDRESS (Public Welcome to Attend) <i>Long-Term Ecological Research in Tallgrass Prairie: The Role of Basic Research in the Conservation of Grassland Ecosystems</i> , Dr. Alan K. Knapp, <i>Kansas State University and KONZA</i>	
9:30	Executive Committee Meeting	Richardson 302

Friday, October 16th

7:00 AM - 5:00 PM	Registration table will be open all day Please check your membership; inquire about audiovisual needs; general information.	Richardson Entrance
7:00 - 8:00 AM	Buffet Breakfast (by Interest Group)	Massman Gallery (Massman Hall) Richardson 206
9:00 - 11:30 AM	Sustaining Member Exhibitors	Richardson 206
8:15 - 11:30 AM	CONCURRENT WORKSHOP SESSIONS I 1. Differential Centrifugation Using Density Gradient Beads, Harold Wilkinson, <i>Millikin University</i> 2. Virtual Biology: Design and Implementation of Web-Based Biology Courses, Tim Mulkey, <i>Indiana State University</i> 3. Interdisciplinary Student Projects for Introductory Science and Mathematics Courses, John Jungck, <i>Beloit College</i> ; Anita Salem and Dick Wilson, <i>Rockhurst College</i> , 4. Rediscovering <i>Chlamydomonas</i> , Steve S. Daggett, <i>Avila</i> <i>College</i> and Donna L. Ritch, <i>UW - Green Bay</i> 5. Virtual Problem-based Learning, Karen Klyczek, <i>UW-River</i> <i>Falls</i>	Richardson 227 Richardson 205 Richardson 203 Richardson 221 Richardson 125
9:45 - 10:00 AM	Morning Break (Refreshments)	Richardson 206

11:30 - 1:15 PM	<p>Luncheon and First Business Meeting</p> <p>Are We Preparing Global Citizens? Panel: Dr. Dean Jerringan, <i>Ottawa University, Associate Professor of Science Education (formerly 30-year teacher at Shawnee Mission South High School)</i> Mr. Chris Gentile, <i>Director of Material Engineering and Technical Services; Allied Signal Inc.</i> Mr. Joe Werner, <i>Urban Ecologist, Kansas City Power and Light Co.</i> Mr. John Strickler, <i>Executive Director, Kansas Association for Conservation and Environmental Education</i> Mr. Brad Williamson, <i>Olathe East High School, Monarch Butterfly Project</i></p>	Rockroom (Massman Hall)
1:15 - 2:00 PM	Shareware	Richardson 203/205
1:15 - 2:00 PM	Student/Faculty Posters and Displays	Richardson 'Street'
1:30 - 4:00	<p>CONCURRENT FIELD TRIPS All trips will leave from Massman Hall parking lot. Please note participants of two field trips will miss the 4:00 sessions.</p> <ol style="list-style-type: none"> 1. Powell Gardens - Large horticultural collection -- and walking tour of landscaped garden and nature trails. (BACK AT 5:00PM) 2. Negro Leagues Baseball Museum/ KC Jazz Museum 3. Bayer Laboratories - Animal research facilities 4. University of Kansas Museum of Natural History - Meet with curators of birds and mammals (BACK AT 5:00PM). 5. Linda Hall Library of Technology and Science - Rare book collection and tour of arboretum - walking field trip. (Current exhibit will be George L. Leclerc, Comte de Buffon, <i>Histoire Naturelle</i>) 6. Plaza Shopping Tour - Particularly for spouses - buses will deliver participants to the Plaza and pick them up for return to hotel or campus - self-guided 7. Kansas City Zoological Gardens and IMAX Theater - Buses will deliver participants to the Zoo front door, and pick them up for return to hotel or campus in time for 4:15 sessions or dinner, at the participant's choice - self-guided (unless there are a large number of children, in which case Rockhurst will try to provide two student chaperones). 	
2:00 - 4:00 PM	<p>CONCURRENT WORKSHOPS SESSIONS II</p> <ol style="list-style-type: none"> 1. Developing Teaching Strategies for Case-Based Learning, Margaret Waterman, <i>SE Missouri State University</i>, and Ethel Stanley, <i>Beloit College</i> 2. 3. 	Richardson 125
4:00 - 4:15 PM	Afternoon Break (Refreshments)	Richardson 206
4:15 - 5:00 PM	<p>CONCURRENT PAPER SESSIONS I</p> <ol style="list-style-type: none"> 1. Linking Biology and Chemistry: A First Look, Buzz Hoagland, <i>Westfield State College</i> 2. Enriching the Science Curriculum of Homeschooled Children Through a Community Outreach Program, Mary Haskins, <i>Rockhurst College</i> 3. Students With Disabilities: What Is Our Role? Jill Kruper, <i>Murray State University</i> and Marty Mitchell, <i>Edinboro University</i> 4. The Development of Inquiry-Based Outdoor Classrooms, Ed Story and Mike Quillen, <i>UK-Maysville Community College</i> 	Richardson 125 Richardson 115 Richardson 306 Richardson 302

	5. A Multidisciplinary Inquiry-Based Introduction to Science for Pre-service Teachers: Are Teachers Prepared to Teach Science? Terre Derting and Jimmy Dorris, <i>Murray State University</i>	Richardson 315
	6. Biology Teaching and Teacher-training in China: Echoes of the Cultural Revolution. John Richard Schrock, <i>Emporia State University</i>	
5:30 - 7:00 PM	Posters, Exhibits, Social	Richardson 206
5:45 - 6:30 PM	Social Hour (Cash Bar)	Massman Pub
6:30 PM	BANQUET	Massman Gallery (Massman Hall)
7:30 PM	BANQUET ADDRESS: The Anemone is Not an Enemy to the Clownfish, Dr. Daphne G. Fautin, <i>Professor of Biology, University of Kansas</i>	Richardson 115
9:00 - 10:15 PM	Curricular Issues Discussion (with cash wine/beer bar) "Preparing Global Citizens", Tom Davis, <i>Session Organizer</i>	Richardson 206
9:00 PM	Bus available to hotels	Richardson Front Door
9:00 - 12:00 PM	Jazz Pub Crawl - led by Phil Colombo, <i>Assistant Professor of Chemistry, Rockhurst College</i>	Richardson Front Door
10:15	Second bus will catch up with Crawl if enough discussants are interested	Richardson Front Door
Saturday, October 17th		
8:00 - 9:15 AM	Buffet Breakfast (by Interest Groups; Bioscene Editorial Board; get food and take upstairs to M248)	Massman Gallery
8:00 - 9:15 AM	<i>Bioscene</i> Editorial Board, Ethel Stanley and Tim Mulkey, presiding	Massman 248
8:30 - 10:30 AM	***Open Balloting***	Richardson entrance
9:00 - 11:30 AM	Zoological Gardens - Bus available for spouses/children leaves from in front of Richardson Science Center. Pick up is at 11:15 from Zoo Main Gate for return to campus.	Richardson Front Door
9:00 - 11:30 AM	Sustaining Member Exhibitors	Richardson 206
9:00 - 9:45 AM	CONCURRENT PAPER SESSIONS II	
	1. Burn-Out Revisited. Judith Brett, <i>Hamilton Center</i> and William Brett, <i>Indiana State University</i>	Richardson 302
	2. Science Studio (A science intervention program for middle school girls). Faith Wilson. <i>St. Teresa's Academy</i>	Richardson 315
	3. What do your students say about evolution?, Nancy Sanders, <i>Truman State University</i>	Richardson 125
	4. Teaching Sexual Differentiation: Beyond the Textbooks, Marc Roy, <i>Beloit College</i>	Richardson 306
	5. Collaborative Case-Based Learning for Introductory Biology Students using Molecular Biology Computer Simulations and Internet Conferencing, Mark Bergland, <i>UW - River Falls</i>	Richardson 203
	6. Ideas for Technology Use in Your Anatomy Lab and Lecture with ADAM Software. Kristin Simmon, <i>A.D.A.M. Software, Inc.</i>	
9:45 - 10:15 AM	Morning Break Posters, Exhibits, Refreshments ***Balloting Closes at 10:30 AM***	Richardson 206
10:15 - 11:00 AM	CONCURRENT PAPER SESSIONS III	
	1. Problems of Teaching Large Numbers of Students in General Education Laboratory Classes Involving Many Graduate Student Assistants, Rita Ghosh, <i>Indiana State University</i>	Richardson 125
	2. Gas Chromatography in the Non-Major Environmental Science Course, James Edmiston, <i>Quincy University</i>	Richardson 302

	3. Labs That Work: A Dinosaur Trachways Exercise, Robert L. Wallace and William S. Brooks, <i>Ripon College</i>	Richardson 306
	4. Training Biological Citizens: Definitions and Content, Tom Davis, <i>Loras College</i>	Richardson 315
	5. Learning and Learning How to Learn: A Reflective, Conversational Model. Robert J. Martin, <i>Truman State University</i> and Suzan L. Martin, <i>Moberly Area Comm. College</i> .	Richardson 203
11:00 - 12:30 AM	Luncheon with Business Meeting	Rock Room (Massman Hall)
	BUSINESS MEETING	
	Presidential Address: Karen Klyczek , <i>UW - River Falls</i> and Charlie Bicak , <i>UN-Kearney</i>	
	Election Results: Dick Wilson , <i>Rockhurst College</i>	
	Bioscene: Ethel Stanley , <i>Beloit College</i> , Tim Mulkey , <i>Indiana State University</i>	
	Executive Secretary Report: Marc Roy , <i>Beloit College</i>	
12:30 PM	===ADJOURNMENT OF REGULAR MEETING===	
12:35 - 1:15 PM	Executive Committee Meeting Includes newly elected Executive Committee members!	Richardson 302

If you are interested in presenting a workshop or paper please contact Terry Derting at Terry.derting@murraystate.edu or 502-762-6327.

ABSTRACTS OF SESSIONS

Concurrent Paper Sessions:

S.I.1. Linking Biology and Chemistry: A First Look.

Buzz Hoagland and Patti DePra, *Westfield State College*
During the spring 1988 semester a chemistry faculty and I linked a second semester general chemistry course with a second semester introductory biology course. Sixteen students were co-enrolled in both courses that met for lecture MWF at 8:30 (General Chemistry II) and MWF at 10:30 (Biological Concepts). Students were given a survey designed to determine their understanding of the nature of the link between chemistry and biology at the beginning and the end of the semester. The extent to which each course was modified, the nature of the involvement by each faculty member, and student reactions will be discussed.

S.I.2. Enriching the Science Curriculum of Homeschooled Children Through a Community Outreach Program.

Mary Haskins, *Rockhurst College*
Rockhurst College offers biology laboratories for middle and high school students who are homeschooled. Last year over 100 students attended a 10-week laboratory series held on our campus. The labs, which met once a week for 2 1/2 hours, provided hands-on experiences for students who may not have access to this type of scientific investigation. Benefits of the program include:

- 1) enhancing the science education of homeschooled children
- 2) enhancing Rockhurst's visibility and reputation in the community
- 3) providing teaching experience for undergraduate students who work in the program
- 4) serving as a possible recruitment tool for our College.

S.I.4. Students With Disabilities: What Is Our Role?

Jill H. Kruper, *Murray State University* and Marty Mitchell, *Edinboro University*
Have you had students in your classroom with vision or hearing impairments, cancer, or hemophilia? Students such as these have different types of disabilities that need to be addressed when considering how your students will learn. Despite the fact that most biology educators have had students with some type of disability in their classroom, few institutions require their faculty to be formally trained about their role as educators when teaching students with disabilities.

We will present information to bring you up to date on what is required of the student with some type of disability and the teacher when designing lectures, exams, and laboratories. Specifically, we will address how teaching a biology course to students with disabilities can be very challenging as compared to courses in other disciplines. We will also provide helpful suggestions so that you will be better prepared when you realize you are teaching a student who cannot see, or perhaps, hear you.

S.I.5. The Development of Inquiry-based Outdoor Classrooms.

Ed Story and Mike Quillen, *UK-Maysville Community College*
The presenters of this proposed session have developed a state award winning Outdoor Education Center at Ward Elementary School in Fleming County, Kentucky. Ward Elementary is located in rural Northern Kentucky.

The development of Outdoor Classrooms as a tool for Inquiry-based education is a viable option for today's schools. The developmental process, beginning at site selection and ending in integrated cross-disciplinary curricula is both involved and rewarding. This session will

discuss various processes and pitfalls, and will present a successful sequence from planning through implementation.

The site has been developed with trails, bridges, ponds and a shelter for group instruction. A power-point presentation will guide the participants through the development phase, the curriculum development phase, the teacher and teacher aid in-service and the actual implementation of the outdoor center into the existing school curriculum.

Problems and stumbling blocks will be addressed along with solutions to them so that the center can flourish in the community. Other topics addressed will include: size of site, securing financial support, actual construction, development of activities that can be used, teacher training, teacher aide training and securing the future of the site.

S.I.6 Biology Teaching and Teacher-training in China: Echoes of the Cultural Revolution. John Richard Schrock, *Emporia State University*

With five times our population and a newfound shift in values toward market economy, China faces dramatic difficulties maintaining a rigorous level of scientific literacy. The Cultural Revolution shut down higher education for nearly a decade and the professorate trained before that period is now retiring. The new and vastly younger biology teaching faculty face the loss of a tenure system, the importation of U. S.-style administration, dramatic intellectual needs and continued inadequate resources, and growing student concern with education as job training. However, they maintain advantages in cultural values for education, a very high study ethic, a content-based teacher training system, and an inability to afford educational futurism.

S.II.1. A Multidisciplinary Inquiry-based Introduction to Science for Pre-Service Teachers: Are Teachers Prepared to Teach Science? Terry L. Derting and Jimmy Dorris, *Murray State University*

We present a preliminary evaluation of a recently-instituted multidisciplinary science course that was developed initially for pre-service teachers through funding by the Eisenhower Foundation. The course focuses on physics, biology, and geoscience. Survey and evaluation data for two semesters of the course will be presented and compared with similar data for our traditional non-major courses in geosciences and biological sciences. We will discuss whether the course has resulted in improved student attitudes towards science, improved critical thinking skills, and improved understanding of basic scientific concepts and the process of science. We believe that development of a positive attitude, critical thinking skills, and an understanding of science is essential for adequate preparation of teachers in science. We will also discuss the problems encountered with the development and implementation of a multi-disciplinary course.

S.II.1 Burn-Out Revisited. Judith Brett, *Hamilton Center* and William Brett, *Indiana State University*

Burnout is not merely worn out from working long hours. A contagious malady, it includes discouragement, disillusionment, and low moral. We will cover what burnout is and helpful interventions to cure it, as well as prevention to keep it from overtaking you and infecting others.

S.II.2. SCIENCE STUDIO (A science intervention program for middle school girls). Faith Wilson, *St. Teresa's Academy*

The academic literature still clearly shows that young women shy away from scientific and technical activity despite the importance of these areas in modern society and their future employability. Studies also indicate that young women lose self-esteem beginning with early middle school. Evidence continues to suggest that a single-sex setting can have a positive impact on the above factors. The literature indicates that without further research on the single-sex classroom in a coeducational world we will not know the following: (1) Which techniques, if any, are particularly successful? (2) Is there an age, development stage, or point in a course sequence at which it is especially useful to pursue a single-sex alternative? (3) What strategies are helpful and at what stage is it useful to ease the transition back to the coeducational environment? The long-term rationale for Science Studio is to uncover possible answers to these questions and to impact the overall systemic issue of women in science.

The core Science Studio is a five-day, summer camp held for each of six science modules. During this experiential camp, and subsequent follow-up activities, young women will explore many scientific principals that form the foundation for understanding how the world around them works. Experienced faculty will be co-teaching with St. Teresa's alumnae still in college, majoring in science, and current honor students from the Academy. The honor students will act as role models and mentors.

This single-sex, educational experience will also contain a number of messages about the history and capability of women in science. This, combined with the presence of strong role models, including guest lecturers from the corporate world, will help to counteract the gender bias messages from other sources.

S.II.3. What Do Your Students Say About Evolution? Nancy Sanders, *Truman State University*

What do your students say about evolution? Do you know, or do you think you know? What preconceived ideas do they have about evolution when they walk into your classroom? How do your views shape their views, or do they? I will share with you some of the responses my students give to the question "What do you think/know about evolution?" that I generally ask during the first week of class in my introductory biology classes for majors. I will then share my perspectives on how to address their question and concerns, and I will invite you to share yours!

S.II.4. Teaching Sexual Differentiation: Beyond the Textbooks. Marc Roy, *Beloit College*

Most introductory and many advanced biology textbooks describe mammalian sexual differentiation as a process regulated, in males, by the Y chromosome and the actions of androgenic hormones. Typically, female differentiation is described as being the result of the absence of these factors. In essence, the female phenotype is described as the default form. In this presentation I will show how this model is out-of-date with current research findings and how sexual differentiation in both males and females is due to a complex interaction of biological factors. Discussion will focus on how we can incorporate this changing paradigm into our courses.

S. II.5 Collaborative Case-based Learning for Introductory Biology Students Using Molecular Biology Computer Simulations and Internet Conferencing. Mark Bergland, *UW-River Falls*

This presentation updates *Case It!*, an NSF-sponsored project to engage introductory biology students in critical thinking and problem-solving by making topics in molecular biology more interesting and relevant. Open-ended computer simulations integrated with Internet conferencing will facilitate collaborative case-based learning among teams of students at a variety of educational institutions across the nation and the world.

S.II.6 Ideas for Technology Use in Your Anatomy Lab and Lecture with ADAM Software. Kristin Simmon, *A.D.A.M. Software, Inc.*

Come see new multimedia CD ROM titles for anatomy and physiology. Learn how you can customize software to your specifications. New testing and assessment tools will be demonstrated. Lab guides and student programs will be discussed. Free demonstration software for attendees.

S.III.1 Problems of Teaching Large Numbers of Students in General Education Laboratory Classes Involving Many Graduate Student Assistants. Rita Ghosh, *Indiana State University*

Keeping students alert and attentive is one of the most challenging tasks in General Ed. Lab. classes. These students are not interested in science. They come ill prepared and cannot relate to diverse areas of science. These topics do not touch their daily life. It is no wonder that science laboratory seems even more daunting to a large majority of the Gen. Ed. students who enroll because it is a requirement. Then, there are students who do have good backgrounds, and for them, these courses are too easy to warrant attention. The problem is accentuated by the fact that these Gen. Ed. Science Labs require participation of Graduate Teaching Assistants, who come with varying degrees of background, ability and expertise. Thus they could greatly affect Gen. Ed. students' interest and involvement, if they are not properly trained.

Therefore, it is important for science teachers, strategists and policy makers to devise ways to improve our science education and make it meaningful. To help initiate a dialogue in this important area, I would focus on areas that are pertinent to this discussion.

- (1) How to improve laboratories and make presentations interesting, yet focused.
- (2) How to challenge students to think and come up with simple answers, or motivate them to design simple experiments which they can do at home. We should point out to the students that many things they are enjoying in life are fruits of scientific endeavor.
- (3) Try to include topics and experiments that the students can relate to in their daily life.
- (4) How to overcome many of the cultural hindrances and accept scientific reasoning. It is important not only to appreciate science but to be receptive of diverse thoughts and reasoning.
- (5) How best to train graduate teaching assistants so that they all acquire a good teaching method, communication skill, and attitude. The objective is to insure a degree of uniformity in all sections of the same lab.

S.III.2 Gas Chromatography in the Non-Major Environmental Course. James Edmiston, *Quincy University*

Detection and measurement of environmental toxins found in field samples with gas chromatography techniques provides the non-science major an opportunity to make connections between fieldwork and quantitative lab analysis. GC techniques, using smaller-scale instruments designed for field analysis, are used in non-major environmental science courses. Specific exercises for the quantitative and qualitative analysis of trihalomethanes in water supplies will be provided.

S.III.3 Labs That Work: A Dinosaur Trackways Exercise, or A Test of Alexander's (1976) Model Estimating The Velocity of Bipedal Dinosaurs (a.k.a. students) From the Footprints They Leave in Trackways. Robert L. Wallace and William S. Brooks, *Ripon College*

In an experimental course on the biology of dinosaurs (Dinosaurs: The Course), we had our students test Alexander's (1976) model that the velocity of a bipedal dinosaur is a function of stride length and hip height:

$$\text{thus, } V = 0.7826 (S^{1.67}) (H^{-1.17});$$

where, S - stride length in meters and H = hip height in meters.

To do this our students measured their Foot length (F) and Leg length at the hip (H) and examined that data to test Alexander's assumption that $4F$ is a good approximation of H, at least for humans. The students then became dinosaurs and made trackways on rolls of newsprint of at least 20 meters long. Dinosaur velocity along the trackway (V) was independently determined, and from that data and data extracted from the trackway (S) the students tested Alexander's model. This lab exercise worked well and probably has many applications from high school through college. Besides a special class such as ours, other that might make use of this include courses in general biology for major or non-majors, biostatistics, human and vertebrate anatomy, and paleontology. However, based on experience, we recommend that the trackway be made in a warm hallway rather than a large, poorly heated gymnasium.

S.III.4. Training Biological Citizens: Definitions and Content. Tom Davis, *Loras College*

Participants in this session will discuss first, what is a "good" biological citizen and second, what subject matter should be specifically included to train better biological citizens in a one semester, introductory, non-majors biology course. In the past I have chosen the following six broad topics: a. Cells; b. DNA, Genetics, Heredity; c. Plants; d. Viruses, Prokaryotes, Protoctista and Fungi; e. Evolution; f. Ecology and Environmental Ethics. Third, participants will discuss their ideas on how to best promote active student ownership of this information.

ASSIGNMENT: Participants in this session are asked to prepare and bring to the session their definition of a "good" biological citizen and choose 6 major topics that they would include in a one semester course to train biological citizens.

S.III.5 Learning and Learning How To Learn: A Reflective, Conversational Model. Robert J. Martin, *Truman State University* and Suzanne L. Martin, *Moberly Area Community College*

This presentation examines three approaches to learning how to learn: the traditional realist approach based on the idea of transmission of knowledge, the Piagetian

constructivist approach based on the idea of individual construction of knowledge, and the conversational constructivist approach based on the idea of knowing as a characteristic of communities which embody the interactions which constitute what we think of as knowing. Examples from a non-major biology class are presented with emphasis on helping students learn to learn through content oriented conversations.

Concurrent Workshop Sessions

WS.I.1 Differential Centrifugation Using Density Gradient Beads. Harold Wilkinson, *Millikan University*

Abstract not yet available

WS.I.2 Virtual Biology: Design and Implementation of Web-Based Biology Courses, Tim Mulkey, *Indiana State University*

Today, the traditional classroom is expanding into the home and workplace. Place- and time-bound students are taking courses via the Internet at locations and times which better suits their schedule and lifestyle. This change in instructional delivery impacts the content, scope, and effectiveness of instructional materials. These virtual classrooms can reach larger student populations with a diverse range of backgrounds, interests, and needs. New challenges are presented to faculty charged with the design of instructional materials for the virtual classroom.

This hands-on workshop will provide participants with an overview of the tools available for web course design and implementation. During this session, participants will use selected tools to begin the design of a web-based course. Participants are encouraged to bring on a PC-format disk the syllabus and other materials that they currently use in a course; this will allow the participant to convert these materials into a format useful in a virtual classroom. [Note: no previous experience with HTML or web design is required. Resource materials will be provided to allow participants to continue development of their virtual courseware after the workshop.]

WS.I.3 Interdisciplinary Student Projects for Introductory Science and Mathematics Courses. John Jungck, *Beloit College*; Anita Salem and Dick Wilson, *Rockhurst College*

One of the most important attributes of undergraduate programs that attract and sustain students in science is a thriving community of students and faculty. Such natural science communities help make learning personally meaningful to students and faculty, allowing them to think about connections to other fields of inquiry. The focus of this workshop will be on the ways in which institutions can cultivate an interdisciplinary, research-rich environment. The workshop will be structured around two projects in population genetics: *A Mathematical Model for Weak Selection of Alleles* and *A Mathematical Model for Selection at a Locus with 3 Alleles*. These two projects are part of a collection of interdisciplinary projects created as part of an NSF grant (DUE-9653093) awarded to Rockhurst College. Included in the workshop will be presentations and discussions on the rationale and motivation for including interdisciplinary projects in mathematics and science courses. Participants will be encouraged to experiment with difference implementation methods and evaluate the

suitability of including interdisciplinary projects in their courses.

WS.I.4 Rediscovering *Chlamydomonas*. Stephen S. Daggett, *Avila College* and Donna L. Ritch, *UW-Green Bay*

Chlamydomonas reinhardtii is a eukaryotic unicellular, green alga. It is found in freshwater and moist soil environments. *Chlamydomonas* sp. are biflagellated and undergo a haplontic life cycle characteristic of many algal protists. *Chlamydomonas* has been used extensively as a research system in cell biology and genetics. It can also be readily incorporated into an undergraduate teaching curriculum. There are several exercises that undergraduates can successfully carry out using *Chlamydomonas* at each level of study. We will demonstrate this by carrying out two protocols. One protocol will involve matings between *Chlamydomonas* cells of opposite mating type and the other will explore *Chlamydomonas* phototaxis. Students find each of these protocols to be both educational and exciting.

WS.I.5. Virtual Problem-Based Learning. Karen Klyczek, *UW-River Falls*

This workshop will demonstrate the use of various types of collaborative problem-based learning (PBL) groups in biology classes. The “virtual” in the title refers in part to using Internet conferencing for intragroup and intergroup collaboration, but also to the use of a more open-ended style of problem than is seen in typical clinical case studies. A summary of results obtained with the PBL strategies in Virology and Immunology classes will be presented, after which participants will have an opportunity to try a couple of different internet communication programs to solve sample problems and to design their own problem scenarios.

WS.II.1 Developing Teaching Strategies For Case-Based Learning. Margaret Waterman, *SE Missouri State University* and Ethel Stanley, *Beloit College*

Helping students to become life-long learners who are able to connect biology to their lives is an important goal of science education. One strategy for accomplishing this goal is case-based learning. Learners pursue their own questions, identify and use a wide variety of resources, and present their reasoning and possible solutions.

Join us as we rather interactively consider three cases about students who are engaged in case-based learning using “Kingdoms Entangled: Molecules, Maize, and Malaria” in quite different ways. We will focus on effective teaching strategies for your classroom as well as ours! We will provide a copy of the multi-part biology case “Kingdoms Entangled: Molecules, Maize, and Malaria,” and resource information for each participant as well.

ABSTRACTS OF POSTERS

Biology Textbook Errors in Systematics. John Richard Schrock, *Emporia State University*

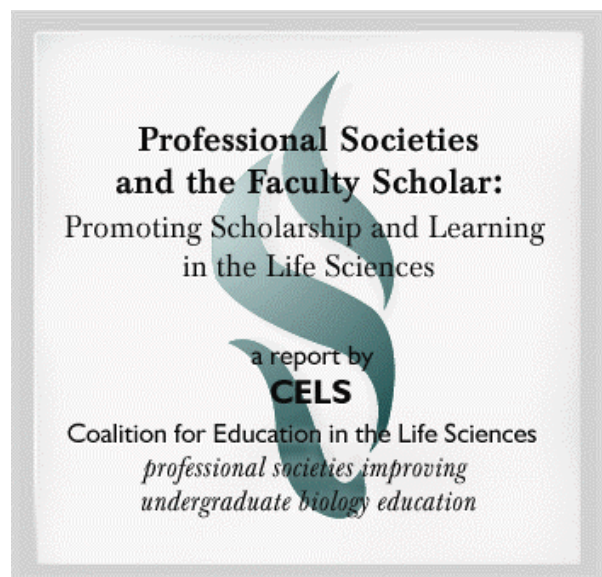
Two generations ago, Dr. Richard Blackwelder first pointed out serious errors in biology publications that confused concepts of classification and nomenclature: calling the specific epithet the scientific name, presenting a hierarchy of groups as classification, etc. Since his retirement, the errors have re-appeared in both high school and college level texts.

Professional Society Leaders Discuss Undergraduate Education

Louise Liao

CELS Program Director

On July 9, 1998, Karen Klyczek, ACUBE President, and John Jungck, past editor of *Bioscene*, met with leaders of 24 other professional societies in the life sciences to discuss their undergraduate education initiatives. The workshop, "Collaborations in Undergraduate Biology Education," was sponsored by the Coalition for Education in the Life Sciences (CELS). Participants exchanged information about undergraduate activities supported by their societies, discussed the types of programs that are well suited to sponsorship by individual societies or clusters of societies, and identified potential roles for CELS in coordinating activities sponsored by clusters of societies.



Workshop participants discussed the nature of teaching as a professional and scholarly pursuit and the place for peer-reviewed educational articles in societies' journals. John and Karen advocated the publication of educational articles and *Bioscene* was held up as model for others to emulate. In Fall 1999, CELS plans to host a workshop on peer-reviewed educational articles in the journals of scientific societies.

Participants also discussed the CELS "Issues-Based Framework for Bio 101," a curricular framework for introductory biology courses. CELS invited the professional societies to enrich this framework by identifying concepts in their own disciplines that are critical to literacy. Dr. David Kramer, chair of the Botanical Society of America Education Committee expressed his hopes that BSA

will examine this framework and showcase hands-on activities that illustrate concepts in plant biology. "I am particularly pleased about efforts to bridge introductory course offerings with the needs of pre-service teachers," commented Dr. Kramer. "Our future teachers will foster lifelong attitudes and beliefs about science in their classrooms."

Education committee chairs from several professional societies recommended that CELS partner with them in coordinating workshops on undergraduate education for their annual meetings. These could focus on teaching as a scholarly pursuit, critical components of biological literacy, and exemplary curricular activities drawn from particular disciplines.

This CELS workshop built on a workshop co-hosted by CELS and the American Society of Plant Physiologists (ASPP) on July 2, 1998. That workshop, "Toward Literacy in Plant Biology," launched a discussion among plant-based professional society representatives on ASPP's document, "Principles of Plant Biology - Concepts for Science Education." ACUBE was represented at that workshop by Margaret Waterman, secretary of ACUBE, and Ethel Stanley and Tim Mulkey, co-editors of *Bioscene*. Undergraduate plant science education, the identification of its underlying principles, and the roles of professional societies were explored by the group in a series of breakout sessions and mini-presentations. A lively discussion of the publication of teaching articles occurred.

These workshops marked the debut of a CELS monograph, *Professional Societies and the Faculty Scholar: Promoting Scholarship and Learning in the Life Sciences*. This 87-page report celebrates the contributions of dozens of professional societies to undergraduate biology education and recommends specific actions to enrich teaching and learning. The monograph can be viewed at the CELS website, <http://www.wisc.edu/cels>. The website also posts information for ordering bound monograph copies and posts the "Issues-Based Framework for Bio 101."

The Association of College and University Biology Educators is a supporting member of CELS, a coalition of professional societies committed to enhancing life science undergraduate education.

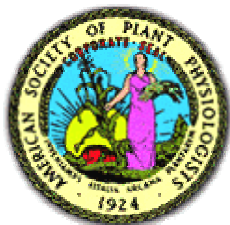
For more information about CELS, contact:

Dr. Louise W. Liao,
CELS Program Director
email: cels@macc.wisc.edu
<http://www.wisc.edu/cels>

Principles of Plant Biology--Concepts for Science Education

John Markwell
University of Nebraska

Many members of the American Society of Plant Physiologists have been concerned with the dearth of plant biology in the K-12 curriculum and being presented to pre-service teachers during their undergraduate training. As a response, the Education Foundation and the Education Committee of the ASPP have developed a set of basic principles of plant biology that the Society is utilizing as a focus for curricular reform. The ASPP is currently attempting to receive broad support from professional societies within the plant sciences and



use the principles during discussions with federal, state and local education groups as well as with textbook publishers. The ASPP hopes to work toward the inclusion of such a basic set of principles into the various national science education standards.

These "Principles of Plant Biology--Concepts for Science Education" can be found on the ASPP web site at the following URL: <http://www.aspp.org/education/asppprin.htm>

We would encourage anyone interested in this project to review the Principles. Comments or suggestions regarding the Principles can be sent to John Markwell at the University of Nebraska (markwell@unl.edu) or Brian Hyps at ASPP (bhyps@aspp.org).

Proposed Principles for Plant Biology

1. Plants contain the same biological processes and biochemistry as microbes and animals. However, plants are unique in that they have the ability to use energy from sunlight along with other chemical elements for growth. This process of photosynthesis provides the world's supply of food and energy.
2. Plants require certain inorganic elements for growth and play an essential role in the circulation of these nutrients within the biosphere.
3. Land plants evolved from ocean-dwelling, algal-like ancestors, and plants have played a role in the evolution of life, including the addition of oxygen and ozone to the atmosphere.
4. Reproduction in flowering plants takes place sexually, resulting in the production of a seed. Reproduction can also occur via asexual propagation.
5. Plants, like animals and many microbes, respire and utilize energy to grow and reproduce.
6. Cell walls provide structural support for the plant and also provide fibers and building materials for humans, insects, birds and many other organisms.
7. Plants exhibit diversity in size and shape ranging from single cells to gigantic trees.
8. Plants are a primary source of fiber, medicines and countless other important products in everyday use.
9. Plants, like animals, are subject to injury and death due to infectious diseases caused by microorganisms. Plants have unique ways to defend themselves against pests and diseases.
10. Water is the major molecule present in plant cells and organs. In addition to an essential role in plant structure, development and growth, water can be important for the internal circulation of organic molecules and salts.
11. Plant growth and development is under the control of hormones and can be affected by external signals such as light, gravity, touch or environmental stresses.
12. Plants live and adapt to a wide variety of environments. Plants provide a wide variety of environments for birds, beneficial insects and other wildlife in ecosystem.

ACUBE

Association of College and University Biology Educators

Formerly the Association of Midwest College Biology Teachers (AMCBT)

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- 2. Botany
- 3. Zoology
- 4. Microbiology
- 5. Pre-professional
- 6. Teacher Education
- 7. Other _____

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- A. Ecology
- B. Evolution
- C. Physiology
- D. Anatomy
- E. History
- F. Philosophy
- G. Systematics
- H. Molecular
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- L. Ethology
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The Association of College and University Biology Educators (ACUBE; formerly the Association of Midwestern College Biology Teachers) has placed its rich archive of materials online for the benefit of its membership. This archive includes 42 years of society publications and resources.

Featuring the online ACUBE archives for:

Bioscene: Journal of College Biology Teaching (1975-present)
AMCBT Newsletter (1964-1974)
AMCBT Proceedings (1957-1972)

Other useful ACUBE information includes:

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