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Association of Midwest College Biology Teachers Conference
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This watercolor of a salticid spider, Trite planniceps, was painted by Micah Stanley, an art student at Parkland Community College in Champaign, Illinois.
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Editor:
John R. Jungck
Department of Biology
Beloit College
700 College St.
Beloit, Wisconsin 53511
jungck@beloit.edu
FAX: (608) 363-2052 or 363-2718

Managing Editor:
Teresa Holevas
holevast@beloit.edu

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Bioscene is the official publication of the Association of Midwest College Biology Teachers
STRUCTURE LEADS TO FUNCTION: 
AN INTEGRATED BIOPHYSICAL APPROACH TO 
TEACHING A BIOCHEMISTRY LABORATORY

Peter deLannoy†, LaHoma M. Easterwood‡, Kimberly Bynote† & Stanley Smith*

†Department of Chemistry & ‡Department of Mathematics
Black Hills State University
Spearfish, South Dakota 57783

We have developed and implemented an integrated approach to teaching our biochemistry laboratory. The central theme of our two semester course focuses on the relationship between the three-dimensional structure of a macromolecule and its function. While the first semester lecture focuses in part on the structure and function of protein enzymes, we have found it convenient in the second semester laboratory to focus on the three-dimensional structure of RNA. We chose RNA as our model system for two reasons. First, there are many examples of RNA enzymes in the literature and they fold into unique and complex tertiary structures to function. Second, unlike proteins, small RNA molecules are easily synthesized enzymatically in the laboratory and the thermodynamic parameters can be determined by relatively simple methodologies.

Central to the development of our laboratory was the construction of a curriculum designed to approach research similar to how science is done in the real world. Moreover, a multidisciplinary approach was taken to introduce many different biochemical techniques to the study of a single biophysical system. Students determined the thermodynamic parameters of two related RNA hairpins. Then investigations include designing the single-stranded T7 templates, purifying the DNA oligonucleotide templates, transcribing and purifying the RNA hairpins, quantifying DNA and RNA oligonucleotides, performing thermal melting studies on the UV-vis spectrophotometer, and analyzing data to determine the relevant thermodynamic parameters of the RNA model system.

Background and Course Goals
RNA is involved in a variety of biological functions. Several RNAs are required for protein translation; rRNAs, tRNAs, and mRNAs (Trachsel, 1991). Recently the Escherichia coli 23S rRNA was implicated in the peptidyl transferase activity during translation (Noller et al., 1992). Formation of the spliceosome and removal of the intron from pre-mRNAs requires a combination of five different snRNAs and splicing factors (Nilson, 1994). Numerous catalytic RNAs have now been characterized that function on a variety of different substrates (Gesteland and Atkins, 1993).

The functions of these various RNAs depend on their abilities to form three-dimensional structures (Chastain and Tinoco, 1991). An RNA’s three-dimensional structure is composed of a primary sequence of nucleotides which interact to form secondary structural elements which, in turn, interact to form a tertiary structure. The tertiary interactions that promote formation of the three-dimensional structure are generally assumed to be weaker than the sum of interactions that form the secondary structures (Turner et al., 1988). Thus, the total free energy of formation for a three-dimensional RNA can be approximated by the sum of free energies of formation for its secondary structures.

Secondary structure is formed by the matching of palindromic sequences within the primary sequence, usually purine-pyrimidine base pairs, though other, non-Watson-Crick base pairs have been noted (Saenger, 1984; Morse and Draper, 1995). Secondary structural elements can include double helices, external loops, internal loops, and bulges (Chastain and Tinoco, 1991; Tinoco et al., 1987).

There are several approaches to predicting RNA secondary structure, including phylogenetic studies, structure mapping, and thermodynamic stability (Serra et al., 1994; Turner et al., 1988). The best approach for defining RNA secondary structure is by using a combination of all three
methodologies. The main limitation of the thermodynamic approach is the lack of data for secondary elements other than helices and small external loop sequences (Serra et al., 1994).

External loop stability is dependent on the size of the loop, but may not be dependent on its composition (Groebe and Uhlenbeck, 1988). The stability of an external loop is also dependent on the closing base pair of the loop and the first mismatch in the loop (Serra et al., 1993; Serra et al., 1994). Bulge nucleotides have also been found to affect hairpin stability (Groebe and Uhlenbeck, 1988).

In contrast to external loops in RNA secondary structure, much less is currently known about internal loops and their contribution to overall thermodynamic stability of secondary structure motifs. Most notably, Santa Lucia et al. (1991) have shown that an internal loop stabilizes the duplex when the mismatches are G*A, U*U, or C*C+, and destabilizes the duplex when the mismatches are G*G, C*A, C*U, A*A, or C*C. Whether these trends exist in the internal loops of biologically important RNAs has been the subject of much speculation; therefore, we adopted this question as the working hypothesis for the laboratory. The goal of our course was to determine the thermodynamic contribution of the internal loop to the overall stability of a naturally occurring RNA hairpin (Figure 1). By using in vitro transcription the students synthesized two small RNA hairpins (Figure 1b and 1c), determined their thermodynamic stability, and calculated the thermodynamic contribution of the internal loop to the overall stability of the naturally occurring RNA hairpin.

RESULTS

Course Outline and Structure
Our biochemistry laboratory consists of one three hour laboratory per week. The work described in this manuscript requires considerably more time and it was common for the students to spend about 6-8 hours per week in the laboratory. The class consisted of 18 students that were divided into six groups of three for the duration of the semester. From a teaching perspective, the course was divided into four main parts including macromolecular structure and function, preparation of transcription templates, RNA synthesis, and UV melting studies of the RNA hairpins.

Macromolecular Structure and Function
This portion of the laboratory lasted about four weeks and consisted of lectures and discussions in order to prepare the students for the rigor of the project. During the first laboratory session each group was handed a packet consisting of the relevant literature needed to complete the project. The tutorials started by focusing on the theoretical aspects of proteins and nucleic acids as important biological molecules and finished off emphasizing RNA and the importance of three-dimensional structure to its function. The last two weeks were devoted to the study of the thermodynamics of RNA structure and theoretical aspects behind the biochemical and biophysical techniques used to obtain these quantities.

Preparation of Transcription Templates
A. Purification of the single-stranded DNA templates
In order to carry out in vitro RNA synthesis using the Milligan method (Milligan et al., 1987), the students must first purify and quantitate the top and bottom strands of the transcription tem-

![Figure 1](image_url) (a) Portion of the naturally occurring C. elegans U6 spliceosomal snRNA (Thomas et al., 1990). (b) U61 Hairpin. (c) U62 RNA hairpin minus the internal loop.
plate (Figure 2). DNA oligonucleotides can be conveniently ordered from a number of different companies thereby obviating the need for the chemical synthesis of the template strands on-site. For a class of 18 we ordered a 1 μM synthesis of each of the template oligonucleotides which was more than enough DNA for the laboratory. Choice of the template sequence is critical and we have relied on the conditions to be published elsewhere (deLannoy et al., 1996). In this case, template oligonucleotides were obtained from Oligos Etc., the lyophilized powder adjusted to 500 μl with deionized water, and aliquoted into 40 μl samples ready for student use. Each group was presented with DNA correlating to the bottom strand of the U61 and U62 templates. The top strand was purified ahead of time by the instructor. Each group combined 20 μl of formamide (Sigma Chemical Company) with their samples and fractionated the mixture on a 20% polyacrylamide-7 M urea gel in 89 mM Tris-Boric Acid, pH 8, 2 mM EDTA (20 cm gel and 1 mm spacers; Maniatis et al., 1982). The relevant bands were identified by UV shadowing, cut out, and eluted overnight at 4°C in 10 ml of deionized water. Prior to the addition of the water, the gel slice was crushed in a 14 ml- 17 x 10 mm polypropylene centrifuge tube. Following overnight elution, the supernatant was transferred to a clean dry polypropylene tube and evaporated to 500 μl using the rotary speed-vac evaporator. The students were allowed one week for the evaporation step due to a time requirement of 4-6 hours and they were requested to come into the laboratory on their own time to complete this step. However, depending on local contexts, the instructor may want to do this step for the students. The purified oligonucleotides were precipitated with two volumes of cold ethanol and 1/10 volume 3 M sodium acetate and stored at -20°C. The procedures noted above and those described below should be completed wearing gloves and using sterile solutions. We have found that small structured RNAs are less susceptible to contaminating nucleases than large RNAs; nonetheless, care should be taken when handling the template oligonucleotides as well as the other relevant experimental manipulations described below.

B. Quantitation of the single-stranded DNA templates

The resulting oligonucleotides were quantified by UV-vis spectroscopy using extinction coefficients described previously (Puglisi and Tinoco, 1989). The resulting pellets from above were brought up in 50 μl of distilled water, a 1 μl aliquot diluted 500-fold, and the absorbance measured at 260 nm. For U61 DNA, usually three gel preparations were combined as one isolation procedure which provides a DNA stock solution of approximately 80-120 μM (one gel preparation was 40 μl of crude DNA). The T7 top strand oligonucleotide should be in the range of about 300 μM. Typically the yields were better for the small oligonucleotides than for the large ones.

RNA Synthesis

A. Hybridization of the template strands

The goal of this portion of the laboratory was to generate the templates needed for T7 transcription of U61 and U62 RNAs (Figure 2a and 2b). In this step equal amounts (350 pmols) of the top and bottom strands of the transcription template were combined in 10 μl of appropriate buffer (10 mM Tris, pH 7.5, 10 mM NaCl, and 0.1 mM EDTA), heated to 100°C for two minutes and snap cooled on ice. The templates must be prepared just prior to performing the transcription since storage of the templates at -20°C decreases the efficiency of transcription (deLannoy et al., 1996).

B. T7 RNA Synthesis

RNA hairpins were synthesized by the in vitro transcription of single-stranded DNA templates by T7 RNA polymerase (Milligan et al., 1987; Ambion, Inc.). Unless otherwise stated the conditions described below were standard procedures from Ambion Inc., with the following modifications. A standard overnight transcription contained the appropriate template (350 pmols; 10 μl from above), and 400 U of additional T7 RNA polymerase in a total volume of 100 μl. Usually, three transcription reactions were set up side by side for a given template, incubated overnight at 37°C and stopped by the addition of 10 U of RNase free DNase I. The volume of each reaction was adjusted to 200 μl with deionized water and extracted one time with 100 μl of chloroform/isoamyl alcohol (24:1) and precipitated with three volumes of cold 95% ethanol. The transcription mixtures were subsequently fractionated on a 20% polyacrylamide-7 M urea denaturing gel as described above. The appropriate band was identified by UV shadowing, purified and quantitated by the procedures outlined above (Maniatis et al., 1982). For transcripts, usually three gel lanes were combined as one isolation procedure which provides an RNA stock solution of approximately 300 μM in 50 μl of deionized water (one transcription preparation was loaded in one gel lane).
a) U61 Transcription Template

5'-GGGAUGACACGCAAAAUUUCGUGAAGCGUUCCAU-3'

TOP STRAND

5'-TAATACGACTCACTATAG-3'
3'-ATTATGCTGAGTGATATCCCTACTGTGGTTAAGCACACTTCGCAAGGTA-5'

BOTTOM STRAND

b) U62 Transcription Template

5'-GGGAUGACGCAAAAUUUCGUGAAGCGUCAU-3'

TOP STRAND

5'-TAATACGACTCACTATAG-3'
3'-ATTATGCTGAGTGATATCCCTACTGTGGTTAAGCACACTTCGCAAGGTA-5'

BOTTOM STRAND

Figure 2. The single-stranded DNA templates used for the in vitro transcription of the (a) U61 and (b) U62 RNA hairpins are shown above.

UV Melting Studies of RNA Hairpins

A. RNA Hairpin Sample Preparation

The conditions used for the melting studies were by Puglisi and Tinoco, (1989) with the following modifications. The buffer used for thermodynamic studies was 10 mM sodium cacodylate, pH 7 with NaCl as specified below. In these experiments, NaCl concentration was maintained at 10 mM with an RNA concentration of 3 μM. The specific amounts needed of each were determined based on the molarity of the stock solutions and the fact that total volume required for the quartz cuvette (0.5 cm path length, Hellma Cells, Inc.) was 200 μl. Samples were mixed taking care to centrifuge between each additional aliquot. When all aliquots had been combined in the Eppendorf tubes, the RNA sample was placed in a water bath, brought to a rolling boil for 3 minutes, and snap cooled in ice. The sample was again centrifuged and loaded in the cuvette for spectral measurements. After the sample was loaded, the cuvette was placed into the cell holder.
Figure 3: A typical melting curve is shown for U61 (3 μM RNA and 10 mM NaCl) with upper and lower base lines (- - -). The curves are plotted Temperature (°C) vs. Absorbance.

of the spectrophotometer with a spacer (Hellma Cells, Inc.) and several spectral measurements were taken at short intervals of 1 to 5 minutes to ensure equilibration of the instrument as well as the sample. The A_{260} should be noted as this value will be used for determination of the integrity of the sample for further experiments using the same sample.

B. Data Acquisition

Absorbance vs. temperature melting curves were measured at 260 nM with a heating rate of 0.2°C per minute on a Hewlett-Packard 8452A spectrophotometer interfaced with a Hewlett-Packard Peltier temperature controller. Absorbances were taken over a particular temperature range with data acquisition every 0.2°C with an integration time of 3 seconds. After each experiment, samples were allowed to cool back to the starting temperature, the A_{260} was recorded and compared to the initial A_{260}, and if the value differed by more than 1%, the sample was not used for a consecutive experiment. A minimum of two experiments was obtained for each RNA hairpin tested.

C. Data Analysis

Upon completion of each experiment, the results were checked graphically on the UV-vis spectrophotometer. The typical melting curve which was obtained is shown below in Figure 3.

The acquired data was transferred from the UV-vis spectrophotometer to a Power Macintosh 6100/650 where they were imported into a spreadsheet package (Cricket-Graph III, version 1.5.3) and converted to vector format. After the transformation, the data in vector form were transferred into Student Edition of Matlab 4a for Macintosh (The MathWorks, Inc.). This program is a numeric computational tool which allows the determination of the thermodynamic parameters of the hairpins based on the van't Hoff relation and standard thermodynamic equations described previously (Puglisi and Tinoco, 1989). Once the thermodynamic parameters were obtained, the standard deviations for the experiments were determined. The data were accepted only if the standard deviations were within published experimental error values (Santa Lucia et al., 1991). The thermodynamic parameters obtained are noted in Table 1.

Discussion

The laboratory described above was implemented in the spring semester of biochemistry at Black Hills State University. The course was an ambitious undertaking and required a large time commitment from both the students and the faculty member who taught the course. All or part of the laboratory described may be adopted or used by others. For example, a shorter more abbreviated laboratory regarding the thermodynamics of RNA structure could be taught by simply providing the students with the appropriate RNA for melting analysis. A laboratory of this nature could conveniently be completed over a four week period including the time required for theoretical discussions.

<table>
<thead>
<tr>
<th>T_m (°C)</th>
<th>ΔS° (cal/mol·deg)</th>
<th>ΔH° (kcal/mol)</th>
<th>ΔG° (kcal/mol)</th>
</tr>
</thead>
<tbody>
<tr>
<td>U61</td>
<td>45.16</td>
<td>-182.2</td>
<td>-57.9</td>
</tr>
<tr>
<td>U62</td>
<td>62.44</td>
<td>-222.3</td>
<td>-74.6</td>
</tr>
</tbody>
</table>

Table 1. Thermodynamic parameters of 3 μM U61 and U62 at 10 mM NaCl. The T_m varied +/- 0.19°C and the standard deviation was ±4.9 kcal/mol for ΔH°, ±15 cal/(mol·deg) for ΔS° and ±0.14 kcal/mol for ΔG°. The data shown below were determined from a minimum of two melting profiles each.
Additionally, other templates could be chosen in order to synthesize and analyze other small RNA structures (Milligan et al., 1987). However, we recommend that other potential sequences maintain the first two Cs in the template since removing them resulted in significantly decreased transcription yields as previously reported (Milligan et al., 1987). Moreover, care must be taken to set up the transcription reactions at room temperature since the transcription buffers used for these reactions contain spermidine which would precipitate the DNA templates if the reactions were set up on ice. Finally, one may also choose not to use the transcription kits from Ambion, Inc.; however, we have found them easy to use, have optimized the templates described above using this system, and the kits can be stored at -20°C for at least one year with little or no loss in T7 RNA polymerase activity.

Denaturing gel electrophoresis was used to purify both the DNA oligos and RNA products. Since polyacrylamide is a neurotoxin, it was recommended that the students wear gloves when handling the gels or gel products. Additionally, in order to avoid degradation problems with regards to the RNA transcripts the students were encouraged to wear gloves during the laboratory steps mentioned above and sterile technique was emphasized throughout the laboratory.

Once the RNA was in hand the students were able to complete two melting profiles each day. The students were encouraged to analyze their melting curves immediately following a melt in order to determine the viability of the data. Thus, a new melt could be set up with a fresh sample of RNA if the previous melt failed or the data was statistically invalid. This was important since each melt required about 8 hours to complete and each group was required to obtain two statistically significant melting curves for U61 and U62 respectively. The data from each group was combined and used by the entire class to complete the group papers and presentations.

In terms of student assessment, each group was required to write a scientific paper and present a seminar describing their results. Initially the students were assigned the abstract and introduction which they had to complete within the first two weeks of the laboratory. This provided the students with the opportunity to obtain a solid grasp of the concepts behind the project and also provided the instructor with a mechanism to determine which groups had conceptual problems. The written portion of the laboratory developed along with the laboratory so that by the end of the semester each group had created a quality product. This resulted in the students approaching science in a real world manner and provided an environment that fostered the mentor-student relationship similar to academic and industrial research laboratories.

Acknowledgments

This work was funded by a grant from the Black Hills State University Faculty Research Fund. We would also like to thank Joseph Howell and Steve Sachs for technical assistance and Dorothy Keller for administrative assistance.

Literature Cited


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The American Society for Microbiology recently announced a national curriculum development program for teachers to develop innovative teaching approaches using the "Biofilms" CD-ROM (see page 12). Curricular approaches being sought include both classroom (lecture) and laboratory activities. Application deadline is February 15, 1997. "The CD-ROM fills an important gap where faculty rarely have had copyright free material for classroom use. The seed grants for faculty training are essential because faculty have little experience in using this new technology," says Jean Douthwright of Rochester Institute of Technology and Chairperson of ASM's Division on Microbiology Education. For more information contact:

Janet Bauer, Office of Education and Training
American Society for Microbiology
(202) 942-9283; Email: jbauer@asmusa.org; web site: http://www.asmusa.org/edu1/htm

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VOL 22(3): December 1996 BIOSCENE 9
STUDENTS TEACHING STUDENTS:
HABITAT TOURS, AN OUTDOOR LAB EXERCISE

Thomas A. Davis
Department of Biology
Loras College
Dubuque, Iowa 52004-0178

The outdoor environment is not organized into chapters like a biology text. On a stroll through the woods, one does not encounter carbon atoms first, then proteins, then prokaryotes, and then eukaryotes with increasing complexity as one moves further into the woods. However, certain areas of the woods may contain organisms that are successful in that specific physical environment. These areas are called habitats and each has its representative plants and animals that live and reproduce successfully there (Kormondy, 1984). Recognizing the characteristic living components of different habitats (i.e., reading the landscape; Leopold, 1949) is one of the first steps in understanding how all life is interrelated. It is also one of the first steps in becoming better connected to the natural environment of which we are a part. But many times venturing outdoors into a world of ravenous mosquitoes, venomous snakes and glistening poison ivy can be literally traumatic for many students whether they are biology majors or not. How can we get students to be more comfortable in and better connected to the outdoor environment so that they can relax, use their powers of observation and ultimately, start asking questions themselves about their natural surroundings?

One way is to get them outside more often. An effective method is an extended field class summer trip like Mountain Ecology (Davis, 1993). The students camp in the habitat that they are studying and become immersed in all aspects of that environment. Another method is to conduct outdoor field investigations either on campus or at a local natural area. But how can we get this outdoor experience to be user friendly? How can it be more interactive? How can we get the information that is learned to last longer and be applied later?

Recent studies on teaching strategies have shown that the best learning occurs when students are working in small groups on a specific task or specific question. (Angelo, 1993) These studies also say that information is retained longer when lectures are minimized and replaced with interactive learning sessions where students teach students (Angelo, 1993). The instructor acts as a coordinator, a mediator, a resource person, someone who fills in needed information. Students study a topic and explain the meaning of the concept to each other in their own words using analogies and examples from their everyday lives that make sense to them. This encourages student ownership of that information because they have spent time themselves figuring it out and listening to others explain the topic as well. (Roy, 1996; Angelo and Cross, 1993)

I have used this teaching strategy in several of my outdoor field ecology classes and in several outdoor laboratory sessions in my introductory biology class. In small groups the students read the landscape, observe the living components of the immediate natural environment and answer focus questions about that environment. There are two goals of these investigations. One is to introduce the students to the major plant and animal components of a specific habitat. The second is to use this awareness to reduce anxiety, stimulate appreciation and foster the ability to ask questions about their environment on their own. In this paper I will describe a simple outdoor lab exercise involving students giving tours of a particular habitat to fellow students.

Materials and Methods/Logistics

Prior to the investigation, students were given a brief description and summary of the habitat which they were to read. This summary gave the students an idea of what plants and animals to expect in this area. They were reminded that observations and information gained here will be used to compare with other life zones or habitats later.

Habitat tours—The class was divided into teams of 4 students. Each team was assigned a certain topic that they investigated. In my most
recent Mountain Ecology class, a two week camping trip that investigated and compared the living components in altitudinal life zones at several mountainside sites in Wyoming, 4 students were in a plant team and 4 students were in an animal team. Each member of the team was given a worksheet that contained specific questions for that team to answer (see box at right). Each team member had a notebook, a field guide for the area and binoculars. Each team was given 45 minutes to go out and investigate an area within 1 mile radius of the campsite or parking lot and focus on the questions answered on their sheets. They were asked to keep track in their notebooks of what they saw and questions that arose. They were encouraged to use their field guides and discuss with each other what they were seeing and hearing during their investigation time. Students were encouraged not to pick or sample flowers or vegetation and not to disturb animal signs so that the upcoming tour could see and learn about them later. Field guides that work well are those that include many pictures and descriptions of plants and animals in an area. An example would be the Audubon Nature Guide Series. I used a book called Western Forests by Whitney for my Mountain Ecology class.

When students returned from their group investigations, they took the other student team and the instructor on a tour of their surroundings. They tried to teach the other students about what they saw and other answers to questions from the worksheet. When one student team had completed their tour, the second student team took over. They showed the others what they had observed and learned from their investigation. Team members were kept the same but the assigned plant or animal emphasis was switched when a new habitat was visited.

**Assessment**

After each tour students were given time to write more in their notebooks about what they saw and learned. This time gave them a chance to look at the field guide and habitat description again. They were encouraged to include diagrams, sketches, personal comments and further questions that might be answered later.

After visits to 2 or 3 habitats, students gather with the instructor to begin talking about comparing 2 of the habitats. The instructor may start by giving a few examples of questions like why can’t Aspens survive in the Subalpine zone or why do yellow-bellied marmots get more gregarious as altitude increases? Students ask and answer many of their own questions during this session and, as a result, become knowledgeable and more confident when it comes to write the required paper which compares the plant and animals communities of two
life zones. Students are then given more time to adjust and complete their notes. They are asked to write a statement about the effectiveness of these habitat tours as useful methods of learning about their natural surroundings.

Students hand in the comparison paper and their notebooks to be evaluated. A written exam on plant and animal identification and ecology is also given. They are graded on how well they answered the questions from the tour sheets, on adequate depth in writing about ecological topics that were discussed, on their exam performance and on their overall participation in the tours and discussions.

Disadvantages
The habitat tour technique may be limited to relatively small lab classes and the time it takes to run a tour for each team. Lab classes of twenty students may be the maximum working size. These classes could be divided into 4 or 5 teams. A 3 hour lab session would go by quickly if each team is given 30 minutes to investigate and twenty minutes each to give a tour.

Another approach would be to have the teams start their investigations during the initial lab period and revisit their areas 3 or more times during the upcoming week. This would help them become more familiar with the territory and the living components there. Maybe even one or more night visits could be required. Tours would be run during the next lab period.

It is difficult to get everyone participating in all the lab teams. It may be suggested that each team member must present at least two of the findings during the tour.

Conclusions
I have used habitat tours successfully in several of my outdoor class sessions. The tours get students talking to and teaching other students. They are truly learning from each other. In several groups there was disagreement about the identification of an insect or a flower. They started to question each other and criticize the identification logic that the other students were using. They had their field guides out and were paging back and forth comparing size, color, and predicted habitat. They were asking questions among themselves. They were taking ownership of the information that they were learning. They were becoming aware of, respectful of and better connected to their natural environment as a result of taking these habitat tours with their peers. In many cases students could not wait to go on the next tour to see what they could find. Take the initiative and push back the boundaries of biological education - have your students take you on some habitat tours.

Literature Cited


TAking a second look: 
Investigating Biology with Visual Datasets

Ethel D. Stanley
Beloit College
Beloit, WI 53511

Have you considered the use of biological images as populations to be sampled? Visual datasets allow students to practice necessary visual skills and explore visual approaches to problem solving within specific areas of biology. New visual datasets are presented with an introduction to some of the visual learning strategies along with their use in undergraduate courses. Proactive design of visual learning experiences within the biology curriculum is urged.

KEY WORDS: visual learning, images, datasets, instructional design

The study of biology presents a unique set of visual learning, visual thinking, and visual communication requirements. Students majoring in the biological sciences not only should develop specific visual methodologies, e.g. the microscopic examination of tissues, field identification of organisms, or interpretation of graphic laboratory results, but also be able to utilize their knowledge of images for thinking and communicating within the extensive visual culture of practicing biologists. Knorr-Cetina & Amann (1990, p. 259) note that “the focus of many laboratory activities is not texts, but images and displays.” These are not passive media, but “objects on which work is performed in the laboratory; like other materials handled in the stream of laboratory activities, they are processed” (p. 262). Students should be able to examine these images critically for additional information about the process or source material used to generate them. They should be able to understand the limitations of their own perceptions as well as the tools used to obtain visual information. Most importantly, they must continue to build and rely on visual skills and knowledge throughout their educational and professional lives.

How can we design learning environments that support our students in these objectives? Experiences that integrate visual learning with specific content should be part of the courses we offer. Visual learning can be defined as “the acquisition and construction of knowledge as a result of interaction with visual phenomena” (Seels 1994, p.107). Visual learning is an important component of visual literacy, “the ability to understand and use images, including the ability to think, learn, and express oneself in terms of images” (Braden & Hortin 1982, p. 41). Despite the abundance of images we expect our biology students to be familiar with and use effortlessly, what it means to be visually literate in biology has been largely ignored. With the escalating use of images in our networked society, this expectation increases. The conceptual frameworks of visual learning and visual literacy are essential in the study of all disciplines, not just the biological sciences.

By selecting biological images from specific areas of biology that allow students to practice necessary visual skills and explore visual approaches to problem solving, we can offer visual datasets for use in our courses. A visual dataset may consist of a single image or a group of related images. Each image can be explored through multiple means to provide additional qualitative and quantitative data. Often additional information about the images is provided such as magnification or scale, source material may be identified, or the process by which the image was produced is revealed such as the scanning of an object. Most images we interact with have the potential for further study, but for the purposes of this paper, visual datasets are images explicitly produced for the purposes of visual analysis.

One example of a visual dataset is the Caminacules, an imaginary group of organisms generated by J. H. Camin and described by Robert Sokal (1983, pp. 161-163) that can be used for problem solving activities in evolution, classification, and development. The popularity of this dataset is shown by its inclusion in a variety of curricular materials such as Biology Laboratory, an introductory lab manual (Eberhard 1987, p. 161) and The BioQUEST Library (Jungck & Vaughan 1996) on CD-ROM. Each caminacule has a distinct
set of phenotypic characteristics which can be used to organize the images into groups. Students "visualize" an evolutionary history for the caminacules by constructing a phenogram. Relationships between individual caminacules are determined by the identification and weighting of characters by the students. Despite preferred phenogram results by some instructors, this problem solving experience clearly provides for a rich set of "solutions." It also opens the door for active persuasion based on visual interpretation and logic since these imaginary organisms can not have their behaviors observed, nor their molecular components analyzed. The inclusion of some fossil data (extinct forms) in the large dataset provides new information that obligates students to re-evaluate their visual data.

Figure 1. Examples of figures from the Caminacules.

Figure 2. Longitudinal section of onion root tip as observed by light microscopy at 430X.

Let's consider the use of a slide with a longitudinal section of an onion root tip in introductory biology (Figure 1). This slide is an excellent source of cells showing various mitotic phases. The process of "visualizing mitosis" (Milne & Milne 1958, p. 99) by making a microscopic examination of this tissue has long been a standard laboratory practice. Students are usually asked to identify cells undergoing specific phases. Even students who are not in the laboratory setting may be asked to do this by examining micrographs in their textbook (Campbell, Mitchell, & Reece 1996, p.147). A significant extension of this task is to quantify the cell cycle (Eberhard 1987, p.103) by examining individual root tip slides in lab. Using root tip tissue to learn about mitosis is not new (see Robbins & Rickett 1929, pp. 186-187). However, asking students to gather data from these images by treating the cells as populations for statistical review is an important pedagogical breakthrough. By actively investigating the number of cells in interphase and various stages of mitosis, students have the opportunity to integrate an understanding of the reproductive process with their knowledge of structure of the plant. Students acquire terms used to describe cell structures visibly associated with specific phases through the repetitive process of counting phases. (There's nothing like a bit of extended visual practice to familiarize yourself with these distinctive features.) The differing results shown by individual

There are large visual datasets accessible to most instructors and students that exist at your institution. The microslide collections that can be found in every biology department are incredible visual resources. Despite this, learning experiences with prepared slides are often reductionistic. "Undergraduate students often view light-microscopy laboratories as memorization based courses. Too frequently the only major objectives of such courses is the descriptive naming of microstructures" (Blystone & Blystone 1994, p. 125). It may not occur to students to investigate the microscopic material beyond the identification of structures or an overview of the arrangement of these structures. More data is there than meets the eye and it may be used to enhance their understanding of biology.
counts allow students to address the issue of variability in living systems. Since there is not one correct "answer" to the phase frequency question, a robust set of questions concerning methods of counting and identifying as well as expectations may arise.

Blystone & Blystone (1994, p. 125) describe a wonderfully extended student approach to histological material from an inquiry-based learning perspective where students "view images as datasets." By using image workstations that support digital video microscopy, students can manipulate images that they capture directly from examination of their own slides or provided as digital images by the instructor. Students have access to powerful digital processing software such as NIH Image and Adobe Photoshop which allow them to perform a variety of measurements and manipulations. Examples of this include measuring inner and outer diameters of proximal versus distal tubules in a slide of rat kidney cortex in order to consider functional differences in these structures, creating digital serial sections through the kidney slide and recombining them to reveal a 3-D nephron, and reconstructing a chick embryo by combining several of the serial sections that have been captured from a single slide. Their students learn biology by constructing "visual hypotheses, simulations, and models" (p.131).

Visual resources are increasingly available. Visual databases from many areas of biology are available on CD, laser disc, and the web. Visual datasets are also being published in both text and digital forms. Some of these datasets come with

Figure 4. Whole plant image from Oh Phlox! (Stanley, 1996)

an explanation of the pedagogical implications of their use. The visual dataset of starfish embryos (Figure 3) enables students to explore their understanding of embryogenesis and development as well as increase their understanding of how images are manipulated and chosen for publication (Blystone and Cooper 1996, p. 64).

Oh Phlox! (Stanley 1996, p. 90) includes image files of individual leaves and "whole" views of mature garden phlox plants (Figure 4). It was developed to encourage visual practice prior to and following field study as well as to support visual investigation in biology. Care was taken to reduce the aesthetic bias that is often present in published images of flowering plants by incorporating all the phlox plants in a randomly selected area as images in this dataset.

How can we use datasets in our courses? There are several worthwhile approaches we can take. Let's begin by considering the leaf images from Oh Phlox! as a population to be sampled. Can we use this population to challenge some of the misconceptions or under-investigated biology of leaves? "In most studies of crop canopies or of the foliage of single plants, all leaves are treated as if they had the same properties" (Harper 1989, p.105). By systematic examination of these phlox leaf images, students can easily see that leaves are highly individual. They are much more likely to appreciate that "leaves on a plant or in a crop form a population, an assemblage of things that

Figure 3. Starfish embryo dataset from Image Analysis (Blystone and Cooper 1996).
can be counted, and they are manifestly not all the same. Their heterogeneity derives in part from the fact that they (like a population of rabbits in a field or of blue tits in a woodland) are not of the same age and change their properties as they age (p. 105). Access to whole plant images as well as individual leaf images allow students to examine the leaves with respect to the development of the plant. The stem of the plant can be viewed as a transect through time. This “timesec” perspective provides visual information that is often overlooked by observers. Leaves can be considered in light of their individual and social context. Harper (1989, p. 105) points out the significance of looking at leaves “borne in different positions relative to each other” that “determine which leaves shade which. The positions they occupy within a canopy are also related to their age—in general, young leaves are found in the fringes of a canopy with older ones in the shade.” Students can use *Oh Phlox* to explore the biology of the mature plant through visual inspection and gain the practice they will need to carry out field investigations in the future.

Students could initiate their own investigations by sampling any of the myriad features of this population. They can develop hypotheses and use statistical data to support their ideas. Investigations centered on this dataset might include some standard measures of physical traits such as number of leaves per plant, percent of leaves showing leaf miner damage (Figure 5), average surface area of leaves, or leaf damage per individual leaf miner as an estimate of feeding required by developing larva. A fairly low tech estimate of leaf miner damage can be done by enlarging and printing out the image of the leaf, trimming the image, and determining the weights of the entire leaf and leaf miner “trail.” (Selected areas could be enhanced and then quantified with a digital processing program like NIH Image as well.) Behavior could be studied by determining directionality of leaf miner trails or plant growth responses after endoparasite activity. Students might examine the timing of leaf miner foraging by studying the intervals between leaves with leaf miner damage. Students could measure “green” or pixel density in new versus “old” leaves, analyze leaf shape as evidence of nutritional deficiency. An “eye-opening” experience for many students who tend to rely heavily on illustrations to identify plants in the field is to have them build a model of the “average” leaf from this population to compare with phlox leaves found in their field guide. Student directed activities could extend well beyond this list.

This increase in visual resources that support visual learning is not enough if we do not incorporate them in our courses. There are some questions we can ask ourselves that may help in making decisions about whether or not we should include visual learning objectives as part of our instructional design. Are the images we use in our lectures essential? Do our students question these images or merely memorize them? Gould (1987, p. 16) stated, “scientific illustrations are not frills or summaries; they are foci for modes of thought.” Do we believe this? Are the images we encounter in journals important? If so, where will these images come from in the next generation of biologists? Do we rely on any visual strategies and knowledge that are specific to our discipline? Do our students find visual approaches to investigation in the laboratory or field problematic? If so, let’s reconsider the role of visual learning in the design of our courses.


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**See the "Call for Presentations" on the inside front cover!**

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**Come to Beloit College for the 41st Annual AMCBT Meeting**

**October 16-18, 1997**

Beloit College's attractive 40-acre campus, modeled after those of the early New England colleges, is located a short walk from the downtown business section of Beloit, WI, a community of 36,000 on the Wisconsin/Illinois State Line. Much of the land for the original College grounds was donated by pioneer residents of the community, which was founded in 1836, only 10 years before the College was chartered by the Wisconsin Territorial Legislature. The campus is dotted with pre-Columbian Indian mounds. Beloit's 50 buildings represent a variety of architectural styles and include structures designed by several nationally prominent architects.

Biology students at Beloit enjoy the advantages of small classes, generous laboratory space, and state-of-the-art equipment. They are encouraged to interact extensively with their professors and with each other in an atmosphere of cooperative and collaborative learning. In addition to their regular class work, many biology majors conduct independent research, participate in professional internships, and serve as teaching assistants. The biology department occupies one full floor and parts of two others in Chamberlin Hall of Science—a spacious, well-equipped and air-conditioned building completed in 1967. Six large laboratories (botany, zoology, biochemistry, physiology, genetics/microbiology, and general biology) are designed for class use, and many smaller laboratories house specialized, state-of-the-art equipment used primarily for advanced laboratory exercises, and student and faculty research.

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**Send in your presentation or workshop idea today.**

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**BIOSCENE**

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News and Views

Honorary Life Membership
in the Association of Midwest College Biology Teachers
Sister Marion R. Johnson

Sister Marion Johnson was inducted as an Honorary Life Member in the Association of Midwestern College Biology Teachers on September 20th at the annual meeting this year which was held at Loras College in Dubuque, Iowa. Sister Marion served as President in 1993-1994, as Second-Vice President (1983-1984), as an Executive Committee Member (1985-1988), and twice hosted the AMCBT annual meeting at St. Xavier University. She was also responsible for many years for recruiting vendors to our annual meeting. She is a person who is exceptionally easy to work with, well organized, and knowledgeable. Her many years of service to the membership are deeply appreciated by all of her colleagues.

Sister Marion is exceptionally well qualified not only because has she been a loyal member, active contributor, and officer of the society, she is also personally committed to what AMCBT stands for: Good college biology teaching! When you visit her office at St. Xavier University where she has long been an Associate Professor of Biology, classrooms, or labs, talk to her students, or hear of her enthusiasm for the Indiana Dunes, it is self-evident that her life is dedicated to student learning.

Sister Marion is an avid educator. She has demonstrated this through her teaching, participation in boards, conferences, and organizing. After receiving a B.A. in Biology at St. Xavier University in 1960 and an M.S. in Biology from the University of Illinois-Urbana in 1964, she went on to study and teach courses in Marine Biology, Desert Biology, Psychology, Basidiomycetes, Environmental Studies, Microbiology, Ecology-Evolution, and Plant Cell and Tissue Culture at Stanford, Arizona State, the University of Oregon, the University of Alabama, The University of Tennessee, Scandinavia, Illinois Institute of Technology, the Ecological St. of Galapagos and the Catholic University of America. Obviously, she is a polymath who simply does it all! She has a deep respect for the Kenyan winner of an alternative Nobel prize, Wangari Maathai. Sister Marion invited her and other noted environmental and peace activists to speak at St. Xavier.

Sister Marion is a curriculum innovator. She is one of those few senior professors who constantly is learning new pedagogical styles, adopting and adapting innovative materials, and urging colleagues to try something new or to at least take a look at something. At Saint Xavier she promoted the 4-1-4 plan in order that biology students could have extended field experience; she herself led student trips (courses) to Florida to observe sub-tropical flora and fauna. In addition to AMCBT, she is a member of the National Association of Biology Teachers and a variety of professional biological organizations including the Ecological Society of America, the Botanical Society of America, the Illinois Academy of Science, AIBS, Union of Concerned Scientists and other environmental groups.

Sister Marion is an internationalist. In addition to her interest in Kenya's experiments in afforestation, she has been on a Darwinian pilgrimage to the Galapagos, studied rain forests in Costa Rica, done environmental studies courses in Scandinavia, spent three weeks in the old Soviet Union on issues of importance to Soviet women, frequently served as a host for foreign visitors, and is especially committed to problems of the Third World. Hence, Sister Marion is truly one of the CITIZENS of the world and takes her responsibilities seriously.

Hence, Sister Marion is not only deserving of our praise based on her record of service, but she is an excellent role model for neophyte biology educators as to the satisfactions of a career of dedicated service in college biology teaching.
LISTS, LEADERSHIP AND LEARNING:
ORGANIZING AN EFFECTIVE AMCGBT MEETING

Thomas A. Davis
Department of Biology
Loras College
Dubuque, Iowa 52004-1078

Advanced planning, teamwork and good food are the key elements in running an effective professional meeting. Making long lists, setting deadlines and putting yourself in the place of the meeting participant are important parts of getting organized to host a meeting of your peers at your campus. The goal of the meeting is to foster an environment that promotes effective communication between professional biology teachers. This environment must be made as convenient as possible for the participants. It must be an environment that is easy to prepare for, to get to, to get around in, to communicate in and to relax in. The participants should have everything laid out for them early, by both mail and email, and also in their registration packets when they arrive. Thus, their anxiety and frustration will be minimized and their teaching ideas and classrooms concerns can be focused upon clearly.

This paper may present timelines and details that will help future local arrangement committees prepare for the annual AMCGBT meeting.

Laying the Groundwork Before the February Steering Committee Meeting

Dates for the meeting should be picked two years in advance if possible. A typical meeting starts Thursday night at 6 pm and ends on Saturday about 3 pm. A weekend should be picked that the football team is away. This will ensure that activities associated with the game do not interfere with meeting plans and participants. This weekend should not be too early in the semester either. The 1996 meeting was held Sept. 19-21 which for some people was only two weeks into the fall semester. A weekend between the 3rd weekend in September and the first weekend in November will avoid weather-related travel problems of winter and can take advantage of the beautiful fall colors in many midwest cities.

Once dates are picked, the rooms in the buildings where the banquet and other meals will be served should be reserved at least one year in advance. Adequate space for a maximum of 120 people to attend the banquet should be reserved. Usually about 50 -70 people eat breakfast on Friday morning and about 70 -90 have brunch on Saturday. These rooms should be able to handle speakers and receptions or have adjacent rooms that can be used for these purposes. Also, one other conference room should be reserved for executive board, editorial board and steering committee meetings. This room should hold 20 people comfortably. Audio-visual equipment like microphones, podiums, overheads, slide projectors and possibly LCD overhead plates that can be connected to a computer should be available and workable in these rooms. It is best if the same rooms or two rooms that are adjacent to each other can be used for many if not all of the group gatherings. Even if the initial registration is held here, the participants have a familiar place from which to start and to which to return. This gives a central operating site for the meeting and immediately puts the participants in a familiar situation. It is best also if this site is used only by AMCGBT for the entire length of the meeting which avoids frustration and promotes group bonding.

Sometime in the fall semester one year before the meeting, the permission of the college president, academic dean, and other college administrators should be sought to hold an AMCGBT meeting on campus on the chosen dates. After they have approved, a campus-wide news release should be sent to all administrative offices, food service, and faculty newsletter describing the meeting, its dates, the estimated number of people attending and a brief description of the purpose of AMCGBT. Making your whole campus aware of this meeting will avoid conflicts, generate interest and foster cooperation at the site.

Also at this time, the local arrangements chair should put together a campus and city profile that can be used in Bioscene and the AMCGBT web site to attract people to the meeting. This statement should include facts and unique characteristics of
the college as well as the city and surrounding environment. It should include travel information like airline connections and driving times and directions from major cities. It should give the reader a taste of the area and invite them to come and see it for themselves. This profile should be submitted to the Bioscene editor and the AMCBT web page web master by November 1.

The program chair and the local arrangements chair should work together during December and January preceding the Steering Committee meeting to rough out a tentative meeting schedule with times and rooms included. The program chair should work out the timing and session leaders for the meeting while the local arrangements chair plans where the sessions and activities will occur. Email and FAX communication are essential in this process. The local arrangements chair must select 2 major meeting sites. One site where meals and the banquet will be held has been described previously. The other site is the sessions site. It is best if this site is in one building only. It must include 5 or 6 classrooms for sessions, 1 or 2 computer labs, a central gathering area close to the classrooms with chairs, and a classroom or open area for exhibitors and posters. One other classroom or conference room should be available as a security room for session leaders to store computers, valuables or as a place to prepare or store refreshments.

Classrooms should seat up to 30 people comfortably and each should have an overhead projector and screen. Two standby overhead projectors should be available as well. Several of the classrooms should be laboratories where participants sit at tables rather than individual desks. These rooms should be clean with all laboratory clutter stored. Slide projectors, LCD overhead projection plates and 1 or 2 portable Mac and PC computers on carts should be available for session leaders as well. Quick access to a copy machine is another consideration to include in selecting a good session meeting site.

The meeting usually attracts about 5-10 exhibitors that each require one or two 3x8 foot tables. The exhibitor room should be near or in the refreshment area and should be located centrally to all the session rooms. This room or nearby hallways should have chairs available for participants to relax in.

The computer labs should also be in the same or adjacent buildings. It is best if there is a Mac computer lab and a PC computer lab with about 12-15 computers per lab. The computer center personnel who oversee these rooms should be notified of the planned activities and asked if they could help participants load software or test run programs prior to the meeting.

The local arrangements chair should also put together a list of 5-8 possible field trip destinations and leaders. It is best if these leaders can be local AMCBT faculty. However, personnel that manage or direct the field trip destinations can be selected as leaders, too. Local members of the Audubon Society, Sierra Club, Garden Club, or high school teachers may agree to lead field trips as well. The leaders should decide a maximum number of people per trip. In my opinion, field trips should be a maximum one way distance of 30 minutes by car. They should showcase the local environment and try to give people the opportunity to learn new things about a new ecological community or threatened environment that they have not experienced before. Having a variety of sites is essential. Trips to prairies, wetlands, rivers, woodlands, geological sites, historical sites, or gardens are examples of variety. Field trip leaders can have one or two duties. They can be responsible only for getting the group to and from the site promptly and/or they can be the local expert who involves the participants in learning about the site and its natural interactions. A researcher who uses the area as a study site or a conservation specialist who has seen the place change or stay the same over time would be valuable leaders. A teacher who has had students doing investigations at a site would be able to offer valuable insights into how to best use the land for these purposes.

Another type of field trip that has been offered in the past but is less desirable is a sightseeing trip to the major attractions in a city. I think that these are beneficial only if the group is met by a local expert who has some biological expertise and from whom they can learn something. If the lesson learned could be applied to improved student learning all the better. In my opinion the general sightseeing tours should be avoided and used only as a last resort.

A tentative meeting schedule with a campus map, a list of tentative field trips, directions to the city and the campus and some possible speaker names should be forwarded to all members of the Steering Committee 2 weeks before this group meets at the site usually in February. The local arrangements chair reserves a conference room for
this meeting. The room should seat 15 people comfortably and should have convenient access to parking and food service. The meeting usually begins at noon Saturday with lunch for all. This lunch can be catered by the campus food service. Dinner is held at a local restaurant and the meeting continues back at the conference room until 10 pm or so. The group meets Sunday morning for a continental breakfast around 9 am and finishes business by noon. It is best if the Steering Committee could stay at one or two of the hotels at which the meeting participants are going to stay to see these facilities too. Hotel phone numbers and directions must be sent to Steering Committee members prior to the meeting as well.

Steering Committee Planning Session

The major focus of the February Steering Committee Meeting at the site of the upcoming meeting is to discuss details and agree on a plan of action for the Program Chair and the Local Arrangements Chair. Timing of sessions, speakers, field trips and meals should be finalized. Participants at the regular Fall 1996 meeting enjoyed the general timing of the sessions and overall format of the meeting. One suggestion was to include 25 minutes between sessions to allow interaction between session leaders and participants as well as interaction time with the exhibitors. Another suggestion would be to have an hour for an open discussion session for anyone who would like to attend. This session would address any problems or ideas that anyone would want to present in an informal format. Food service menus should be provided to each member so that all items for the menu for the Thursday reception, Friday breakfast, Friday reception and banquet, Saturday breakfast and Saturday brunch can be chosen here.

Ideas concerning promotional materials that will be given to the meeting participants like bags, mugs, pens, mousepads, shirts, etc. should be finalized and approximate prices and funding sources discussed as well. Corporate sponsors, like publishers or equipment companies, for receptions, refreshments and speakers should be discussed.

In the past, speakers have been chosen according to the following general pattern. One speaker should focus on the teaching of biology. This speaker should be chosen by the program chair or the Steering Committee and their topic should relate to the theme of the meeting. A second speaker is chosen by the local arrangements chair and is usually a local person with some expertise in biology or in a current biologically-relevant issue. A third speaker is chosen by the Steering Committee who is more nationally known for their work in teaching or research.

The committee should also meet with a member of the computer staff to ask about specific needs and capabilities.

Finally the Steering Committee should tour the prospective rooms for the meeting. Computer capabilities should be checked. Room size, location, central meeting area, crowd control and convenience should be addressed on the tour. With these final arrangements made, the local arrangements chair then begins the process of listing needs and looking carefully at the schedule of events to create the proper environment for a successful meeting. All these arrangements or as many as possible should be placed on the AMCBT web page as soon as possible to notify people of the meeting and its schedule.

Considerations from March Through August Before the Meeting

This is the time when the local arrangements chair should organize the other local AMCBT members to divide up responsibilities. Possible individual or two person jobs include food and refreshment arrangements, field trip coordination, directional signs on campus and on roads leading to campus, AV needs, registration/receipts and computer coordination. These individuals or teams should meet monthly until August and then more frequently as the meeting looms closer.

A block of local hotel rooms should be reserved. Usually 20 rooms at one hotel and 20 rooms at another hotel have been sufficient in the past. One thing to make transport even more convenient is to have a hotel shuttle bus available for meeting participants to use between the hotel and campus.

If mugs or bags or “free stuff” are to be part of the meeting, the arrangements for these should be made here. Sponsors that might help pay for these items should be contacted but not before advice of the college development office is received. Many times they can suggest people or groups to contact that might help with this project. The college public relations department might even donate money to your cause. Ultimately, AMCBT should not pay for these
items. And many times all you have to do is ask these groups and the financial support will be there.

This is also time to narrow down the field trip list to 4 or 5 good ones, contact good potential leaders and ask for their participation.

Since the menu has been finalized, it can be discussed with the food service. Care should be given to having enough food selection for vegetarians. Also it has been very important in the past to have some kind of dessert after dinner. Whether it be cherry pie or ice cream or both, some sort of sweet ending to each meal and especially the banquet adds to the success of the whole meeting.

The local chamber of commerce can be contacted and asked if they supply name tags, name tag holders, pens, folders, visitors guides, coupon books, or any other help. Many times these items are given free to the group.

It is a good time to draw up an estimated budget for the meeting. Since the registration fee has been set at the Steering Committee meeting, one can predict from attendance at past meetings how much money will be available to pay for various expenses. The major expenses include food service, field trip transportation, speakers fees, hotels and travel, printing costs and any reservation fees. The AMCBT Executive Secretary can furnish the local arrangements chair with money to cover costs before the meeting. The Executive Secretary can also furnish past meeting attendance records as well.

Exhibitors should be contacted by phone first and asked for their participation. The exhibitor fee is $50. If they agree an exhibitor registration form should be sent to them to confirm their projected presence at the meeting. This form contains space for their name, phone number, product description, display needs and space as well as your address to which they can send their exhibitor fee.

Potential speakers should be contacted and asked for their participation. Each of the three speakers should be chosen and the specific topic of their talk should be finalized with an abstract forwarded to the program chair by July 1. Hotel arrangements for each of the speakers should be made by the local arrangements chair.

The contents of the registration folder that will be given to each participant at the beginning of the meeting can also be outlined and copies made. Sometimes the admissions office has folders that are given to prospective students. This office may be a good source of free folders for your meeting. The following list of materials should be included inside the registration folder:

1) a campus map with parking areas and buildings to be used during the meeting clearly marked.
2) a local visitors guide with city map from the chamber of commerce.
3) host college facts and degree summaries from the admissions office.
4) host biology department summary brochure.
5) a pen or pencil.
6) a receipt on college letterhead that shows which fees were paid by whom and when. This receipt can also carry personalized information like which field trip or workshop the person is scheduled for. This will be used by the participant upon their return to their campus to get reimbursed for attending the meeting.
7) a final program schedule.
8) a copy of all abstracts from all the sessions.
9) a meeting evaluation form.
10) a form to suggest ideas or offer involvement in next year's meeting.
11) a list of local places to eat with addresses for the open lunch period on Friday.

Some of these can be added early to folders while some can be added only the day before the meeting.

Another form that must be available is the recorder form which is filled out by one participant in each session. The recorder form includes the session leader's name, date, number of people in attendance, summary of session topic, comments of recorder, and blank lines for the address of a dean or administrator of the session leader. These forms are returned to the local arrangements chair or the AMCBT secretary so that letters of recognition/participation can be sent to the home campus of each session leader.

Activities One Month Before the Meeting
Each of the speakers should be contacted once more to make sure they have what they need and if they have any questions. A meeting schedule should be forwarded to them and they should be encouraged to participate in any or all of the meeting if they can.
Student helpers should be recruited to operate the registration desk, to help set up tables or poster boards or to be general assistants that can help people get set up before each of the sessions. Biology, education or science education majors have been used successfully in the past.

Once a semi-final program has been received, individual room schedules can be printed that list times, sessions and session leaders for the whole meeting in that room.

Final programs can be distributed to all local biology faculty and they should be invited to participate in any part of the meeting.

A team of people should walk through the meeting sites and decide what kind of directional signs are needed at various sites. Signs for individual session rooms, restrooms and exhibitor room are essential. Several large signs that can be attached to road signs leading to campus may be helpful.

Van or bus reservations for the field trips should be made through the college. If more than 12 people are scheduled for a field trip it may be easier to car pool. Buses are convenient for larger groups but may be expensive as well.

One of the biggest jobs at this time is receiving the incoming registration forms. All the information on each registration form must be recorded and lists made of who is participating in which activity. People are assigned to field trips and workshops on a first come first serve basis. Registration fees, extra guest banquet fees, van transportation fees and other fees are kept track of and listed. Name tags can be printed and registration folders prepared one week before the meeting. Registration forms and all fees should be due two weeks before the meeting so that final numbers for food service, field trips and tours can be forwarded.

Small signs can be printed for use at individual tables at Friday breakfast. These signs denote interest groups and help people meet others with similar interests.

Several refreshment breaks are usually scheduled between sessions especially on Friday afternoon. It can be the responsibility of the local arrangements chair to supply these refreshments. Try to schedule a time that day for a trip to the grocery store can be made. Pop, juice, cookies, fruit, coffee and sweets may help people through this part of the day. Sometimes the food service does not allow any food besides theirs on campus.

Be sure to recontact any session leaders that have indicated special computer needs. Encourage them to get a copy of their programs to you early to have you test them on site. This will avoid the delays due to incompatible software and hardware.

In past AMCBT meetings several multicolored tickets have been issued to participants that give them access to each of the planned meals and activities. In my experience these tickets were never collected and seemed like a large hassle for the local arrangements chair. They were not used at Loras and all events went smoothly.

Special receipts for payment of annual AMCBT dues should be requested from the executive secretary. Some people pay their membership dues at the meeting at registration so this situation should be planned for as well.

A disk with all the forms and meeting information should be passed to the new local arrangements chair. All suggestions and comments from this meetings and ideas for the next meeting should be passed on to the new program chair as well.

Conclusion

The reason why people return to or become active in a particular organization is because they enjoy the people they meet and appreciate the new ideas they receive at the meetings. The role of the meeting is to foster an environment for this camaraderie and communication to take place. This meeting environment must be convenient and congenial. The meals are very important times to share ideas and talk with colleagues. The information presented here should help make future AMCBT meetings and other meetings more effective and attractive. Ultimately, this kind of meeting environment should lead to a more effective learning environment for our students.
### Table 1. List of AMCBT Meeting Timelines and Duties

<table>
<thead>
<tr>
<th>A. Fall Semester One Year Before the Meeting</th>
<th>B. Steering Committee Planning Session</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dates Chosen</td>
<td>Promotional Materials</td>
</tr>
<tr>
<td>Facility Reservations</td>
<td>Menus</td>
</tr>
<tr>
<td>Administrative Approval</td>
<td>Speakers</td>
</tr>
<tr>
<td>College and City Profile</td>
<td>Meeting Schedule</td>
</tr>
<tr>
<td>Tentative Meeting Schedule</td>
<td>Tour of Sites on Campus</td>
</tr>
<tr>
<td>Two Major Meeting Sites</td>
<td></td>
</tr>
<tr>
<td>Classrooms</td>
<td></td>
</tr>
<tr>
<td>Exhibitor Room/Area</td>
<td></td>
</tr>
<tr>
<td>Computer Labs</td>
<td></td>
</tr>
<tr>
<td>Field Trips</td>
<td></td>
</tr>
<tr>
<td>Mailing to Steering Committee</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>C. Spring Semester Before the Meeting</th>
<th>D. One Month Before the Meeting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local Planning Committee</td>
<td>Speakers</td>
</tr>
<tr>
<td>Hotel Rooms</td>
<td></td>
</tr>
<tr>
<td>Sponsors</td>
<td>Student Helpers</td>
</tr>
<tr>
<td>Field Trips</td>
<td>Directional Signs</td>
</tr>
<tr>
<td>Menus and Food Service</td>
<td>Room Schedules</td>
</tr>
<tr>
<td>Chamber of Commerce</td>
<td>Final Programs</td>
</tr>
<tr>
<td>Estimated Budget</td>
<td>Vehicle Reservations</td>
</tr>
<tr>
<td>Exhibitors</td>
<td>Incoming Registration Forms/Procedure</td>
</tr>
<tr>
<td>Speakers</td>
<td>Refreshments</td>
</tr>
<tr>
<td>Registration Folder Content</td>
<td></td>
</tr>
<tr>
<td>Recorder Forms</td>
<td></td>
</tr>
</tbody>
</table>

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1997 INTERNATIONAL SCIENCE AND ENGINEERING FAIR AT LOUISVILLE, KY
DECLARATION OF INTEREST IN BECOMING A GRAND AWARD JUDGE

Formal recruitment of judges will not begin until the Fall of 1996. However, it will greatly facilitate that process if we have a bank of names of individuals who are seriously interested in being a judge.

Science Service, Inc., of Washington is the agency that conducts these international events, and they set the criteria for becoming a judge, which read as follows:

"All judges should have a Ph.D., M.D., or equivalent OR a minimum of six years related professional experience. Judges may include university faculty, industrial scientists and engineers, representatives of private and federal research centers and agencies, and medical researchers. Affiliated science fair directors, ISEF Official Party members, or elementary or secondary school teachers are not eligible to judge."

Meals for judges will be provided. However, budget restraints will not allow travel and lodging expenses. Judges are expected to be available from Monday, May 12 through Tuesday, May 13, 1997 to complete their judging assignments. For further information contact:

Ray Reed  
Jefferson Community College  
109 East Broadway  
Louisville, Kentucky 40202  
phone: (502) 584-0181 (x2276)  
Fax: (502) 584-0181 (x2421)
ASSOCIATION OF MIDWESTERN COLLEGE BIOLOGY TEACHERS

NAME: ___________________________ DATE: ___________________________

TITLE: ___________________________

DEPARTMENT: ___________________________

INSTITUTION: ___________________________

STREET ADDRESS: ___________________________

CITY: ___________________________ STATE: ___________________________ ZIP CODE: ___________________________

ADDRESS PREFERRED FOR MAILING: ___________________________

CITY: ___________________________ STATE: ___________________________ ZIP CODE: ___________________________

WORK PHONE: ___________________________ FAX NUMBER: ___________________________

HOME PHONE: ___________________________ E-MAIL ADDRESS: ___________________________

MAJOR INTERESTS: ___________________________

( ) 1. Biology  ( ) A. Ecology  ( ) H. Molecular
( ) 2. Botany  ( ) B. Evolution  ( ) I. Developmental
( ) 3. Zoology  ( ) C. Physiology  ( ) J. Cellular
( ) 4. Microbiology  ( ) D. Anatomy  ( ) K. Genetics
( ) 5. Pre-professional  ( ) E. History  ( ) L. Ethology
( ) 6. Teacher Education  ( ) F. Philosophy  ( ) M. Neuroscience
( ) 7. Other  ( ) G. Systematics  ( ) N. Other

SUB DISCIPLINES: (Mark as many as apply)

RESOURCE AREAS: ___________________________

RESEARCH AREAS: ___________________________

How did you find out about AMCBT? ___________________________

Have you been a member before? ________ If so, when? ___________________________

PLEASE MAIL MEMBERSHIP APPLICATION FORM TO:

Marc M. Roy
Executive Secretary, AMCBT
AMCBT Central Office
Department of Biology
Beloit College
700 College Street
Beloit, WI 53511
Phone: 608-363-2429—FAX: 608-363-2052 or 2718
Email: roym@beloit.edu

CURRENT DUES ARE $25.00
$15.00 for Graduate Students
Welcome to the AMCBT Home Page:

URL: http://papa.indstate.edu/amcbt

Featuring the online AMCBT archive for:

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

Other useful AMCBT information includes:

- AMCBT Executive Committee
- Editorial Board of Bioscene
- 1995 Annual Meeting of the AMCBT
- Searchable Membership Database (coming soon)
- On-line Membership Application
- Archive of the AMCBT ListServer
- Scientific Meetings of Interest to Membership
- Position Announcements
- AMCBT in the News

The Association of Midwest College Biology Teachers has developed its own list server to facilitate communication between its members. The purpose of the AMCBT mailing list is to provide announcements, information and discussion of a wide variety of topics.

Information mailed to:

amcbt-l@biology.indstate.edu

will be sent to all members of the list.

To subscribe/unsubscribe to the list, send e-mail to:

list-admin@biology.indstate.edu

To subscribe, send this message line:

subscribe amcbt

To unsubscribe, send this message line:

unsubscribe amcbt

If you have any questions about AMCBT-L, contact Tim Mulkey at mulkey@biology.indstate.edu