Despotic Ducks

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Abstract: This field experiment is designed to test for despotic behavior in Mallards (Anas platyrhynchos), and to examine how ducks distribute themselves relative to their resources. Students present Mallards with food patches differing in profitability in order to examine whether ducks distribute themselves ideal freely or ideal despotically. Students also test whether foragers have equal competitive ability, and look for despotic behavior among individuals. Despotic behavior is when certain individuals monopolize resources and prevent others from gaining access to those resources. This exercise is designed to allow students to be involved in every step of the scientific process.

Keywords: despotism, foraging, ideal free distribution, despotic distribution, ducks.

Introduction

Often it is challenging to find field experiments that can be conducted in a reasonable amount of time, and that will provide useful data for analysis. Yet, students enjoy field experiments; and hypothesis-testing experiments enabling students to collect and analyze data provide students with valuable research experience (Darling 2000). This field exercise provides students with an opportunity to conduct a hypothesis-testing experiment, and analyze their results.

Fretwell and Lucas (1970) and Fretwell (1972) proposed the ideal free distribution (IFD) theory to explain how animals should distribute themselves within an environment containing patches of varying suitability. The ideal free distribution theory applies to situations when there is competition over a resource which is patchily distributed (e.g. food or mates) and the following conditions are met: 1) individuals are ‘ideal’ in assessing patch quality (i.e. they have complete information about the availability of resources), 2) individuals are ‘free’ to enter or leave any patch of their choice (there is no resource defense), 3) patch quality decreases with increasing competitor density, 4) all individuals select the most profitable patch while compensating for existing competitors in the patch, and 5) all individuals have the same competitive ability.

If these conditions are met, the IFD theory predicts that the number of individuals per patch will be proportional to the fraction of resources in that patch. The theory also predicts that the intake per individual will be equal across all patches.

According to the IFD theory, if there is a group of twenty-four ducks feeding in a pond that has pieces of bread distributed in two patches, and one patch has twice as many equally-sized pieces of bread as the other patch, you would expect that there would be eight ducks in the poor patch, and sixteen ducks in the rich patch. Furthermore, the IFD predicts that the food intake (number of pieces of bread consumed per duck) will be equal in both the rich and poor patches.

A number of studies have tested the ideal free distribution theory in a variety of species, and have found that animals tend to distribute themselves as predicted (Milinski 1979; Harper 1982; Power 1984; Godin and Keanleyside 1984; Gillis and Kramer 1987; Darling 1989; Baum and Kraft 1998). However, often individuals do not get equal shares of the resources. Often, dominant individuals obtain more than their fair share of the resources (Milinski 1979; Harper 1982; Desrochers 1989; Baum and Kraft 1998; Cresswell 2001). These dominant individuals may act as despots chasing subordinates away from the resources (Milinski 1979; Harper 1982; Desrochers...
In my class, after I have introduced the students to the ideal free distribution theory and the ideal despotic distribution, I engage the students in a discussion about experimental design. Rather than give students the methods, I prefer to encourage the class to think about the issues involved with designing an experiment, and allow them to design their own field experiment. I have outlined questions and issues that the class should discuss below.

**Field Location**
Before conducting this exercise, the instructor needs to locate an appropriate field location. A local park, pond, stream or wetland area may provide a suitable location. Because ducks often aggregate in rural areas as well as in urban and suburban parks, this experiment works well in a variety of settings.

Mallards (*Anas platyrhynchos*) are a common duck species found in many locations, and work well for this experiment. It is not necessary to have a large population of ducks, but you will need approximately eight ducks. If you do not have a location with a duck population nearby, this exercise can be easily adapted to work with other bird species. For example, you could do this exercise in a park using pigeons as your study species, and using a large seed as your food (such as sunflower seeds or peanuts).

**Time of Day**
Students should discuss when the experiment will be conducted and how long trials will run. One of the assumptions of the IFD model is that the foragers are hungry. Therefore, students will get the best results if they conduct the experiments early in the morning, when the ducks are hungriest. This is especially true of park populations of birds that are fed, and become quickly satiated.

**Food**
The class should discuss the food type and quantity to be used. Have students prepare the food to be used ahead of time. Pieces of bread are a good food source to

The class should discuss the experimental design. What patch profitability ratio(s) will be tested? For example students could test a 1:1, 2:1, 3:1 or 4:1 ratio. Continuous input experiments work well (food is continually input into the two sides of the

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**Methods**
Use when conducting this experiment with ducks. Buy several loaves of bread. Cut each bread slice into pieces (use quarters if you don’t have many ducks in your area, use eighths if you have a lot of ducks).

**Experimental Design and Procedures**
pond at the appropriate ratios). For instance, the class would test a 2:1 ratio by throwing bread continually into the two sides of the pond: throwing in twice as many pieces of bread in the “rich” side as in the “poor” side. Perhaps students may decide that every twenty seconds they will throw ten pieces of bread in the poor patch, and twenty pieces in the rich patch.

What will the control be? The control should be the initial distribution of the ducks prior to throwing in food. When students first arrive at the study site, before conducting any manipulations, students should observe the distribution of the ducks for a set amount of time (perhaps five or ten minutes). During this control period, students should record the number of ducks on each side of the pond at regular intervals.

How many times will students replicate the experiment? Running replicates of the experiment over several days will enable the class to collect sufficient data to run statistical tests. Once a field location is selected, and the students have decided on an experimental design, they can begin collecting data.

What items and equipment will be needed? Students will need bread, stopwatches, tape measures, flagging, paper, and pens for recording data.

Helpful Hints

This experiment works best if the food does not become completely depleted; therefore it is best to choose a sufficient quantity of food for the population of ducks in your study area. It may take a little experimentation to determine the appropriate quantity of food.

Students should count out the appropriate number of pieces of bread and put them in Ziploc bags so that each time they need to add food, it is already counted out.

The pond should be divided in half. Students should measure the midpoint of the pond and mark it with visual markers that they can see (e.g., small pieces of flagging tape near the edges) so that when they are counting which side of the pond ducks are on, they will know where the midpoint is.

Time periods of five to ten minutes in length work well for the experiment. Time periods longer than this may result in ducks becoming satiated.

At each end of the pond two students could be responsible for throwing in the food. Students could work in pairs; one student could have a stop watch and let the other student know when it is time to throw in the food. Another two students (at each end of the pond) should collect data on number of ducks. Additional students can follow ‘target’ ducks to collect data on the amount of food consumed on each side of the pond.

If one of the desired outcomes is to conduct statistical analysis, then 8 to 12 replicates of the experiment is preferable.

Data Collection and Analysis

The instructor can lead students through a discussion of what data should be collected to test the predictions of the IFD theory and the ideal despotic distribution. Students should periodically (e.g., every twenty or thirty seconds) record the number of ducks in the pond, in both the rich and poor patch, during both the control and feeding periods.

Students should also record the number of food items consumed on each side of the pond for individual ducks. It probably will not be possible for students to record food intake for every duck. Therefore have different students randomly select several ‘target ducks’ to follow throughout each trial. For each target duck, students will want to follow the duck and record how many bread pieces that duck eats in the poor patch, and how many pieces it eats in the rich patch. Students should also record observations about despotic behavior. Are the target ducks chasing other ducks from the food? Or, are they being chased from the food?

Graphing the data will let students visualize whether the ducks distribute themselves according to the predictions of the IFD theory. Students can graph the results to observe if:

1) Ducks are distributed equally on both sides of the pond during the control period as expected.
2) The number of individuals per patch is proportional to the fraction of resources in that patch during the feeding period.

To address these two predictions, students can plot the mean number of ducks on each side of the pond for the control and the feeding periods respectively (see Figures 2 and 3).

Figure 2. The mean number of ducks recorded in each patch of the pond (the left and right patches) during the control period of the experiment. Because no food is added to either side of the pond during the control period, it is expected that there should be approximately equal numbers of ducks on both sides of the pond.

Students can also graph the food intake per duck to examine if all of the "target" ducks have approximately equal competitive abilities or whether some ducks consume more food than others.

Students can statistically analyze the data to determine whether:

1) There were equal numbers of ducks on both sides of the pond during the control period as expected. To test this expectation, students can calculate the mean (mean ± SE) number of ducks on each side of the pond during the control period and compare the means statistically by performing appropriate statistical tests (e.g., t-tests or Mann-Whitney U tests).

2) The number of individuals per patch is proportional to the fraction of resources in that patch. To test this expectation, students can calculate the mean (mean ± SE) number of ducks on each side of the pond during the experimental period. The mean number of ducks can be compared to the expected number of food items consumed on each side of the pond during the feeding period. The means can be compared statistically by performing appropriate statistical tests (e.g., t-tests or Mann-Whitney U tests).

Figure 3. The mean number of ducks recorded in each patch of the pond (the rich and poor patch) during the feeding period of the experiment. The rich patch contained twice as much bread as the poor patch. If the ducks behaved ideal freely, the expectation is that there would be twice as many ducks in the rich patch as in the poor patch. 

3) The food intake per individual is equal across patches. To test this expectation, students can calculate the mean (mean ± SE)
4) The average food intake is equal among all ducks. To test this expectation, students can calculate the mean (mean ± SE) total number of food items consumed (on both sides of the pond) during feeding periods by a given duck. The means for different ducks can be compared statistically by performing appropriate statistical tests (e.g. ANOVA or Kruskal-Wallis test to compare means).

Questions students can address include: Did the ducks distribute themselves according to the predictions of the IFD theory? If the ducks did not distribute themselves according to the IFD theory, why not? Were the assumptions of the IFD theory met? Were all ducks equal in their competitive ability, or were some ducks superior competitors? Were some ducks despotic, taking more than their fair share of the resources and keeping others away from the resources?

Students can present their results in written laboratory reports (in scientific format) and/or orally present their results. For lower division courses, students could write a shorter report by answering a series of questions provided by the instructor.

In conclusion, this field exercise provides students with an opportunity to be involved with designing and conducting an experiment, and analyzing and summarizing their results. Often it is challenging for instructors to find field laboratory experiments that involve testing a hypothesis. This exercise provides a hypothesis-testing field experiment that is fun to do and gives interesting results.

Acknowledgments
I would also like to thank the students in my Animal Behavior course for their ideas and enthusiasm.

References


Learning About Cells as Dynamic Entities: An Inquiry-Driven Cell Culture Project

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Abstract: Using cultured fibroblast cells, undergraduate students explore cell division and the responses of cultured cells to a variety of environmental changes. The students learn new research techniques and carry out a self-designed experiment. Through this project, students enhance their creative approach to scientific inquiry, learn time-management and group interaction skills, and communicate their ideas and results in written and oral form. A Likert scale pre/post assessment was administered for three semesters to determine changes in student attitudes.

Keywords: cell biology, cell culture, laboratory project, independent learning, inquiry-based project, fibroblast cells

Introduction

Helping students to understand and visualize function at the level of cells and molecules can be quite challenging. After all, students cannot see or touch a single cell without the aide of technology, nor can they open one up and look inside. As with many biological functions, we are restricted to what we can observe indirectly about cell function to help us understand these essential units of life. In our attempts to help students make the mental leap into the microscopic world of cell function, we have begun to use cultured cells during a sophomore level Cell and Molecular Biology (CMB) course. This paper outlines our approaches and techniques in using cell culture as a teaching tool in the hopes that others may also find it beneficial to their students. Similar approaches have been used in a summer biotechnology program (Lewis et al., 2002) and in teaching apoptosis to advanced students (DiBartolomeis and Moné, 2003). Ledbetter and Lippert (2002) also report using cultured cells in a short-term laboratory project investigating membrane transport.

This laboratory exercise has been used at a liberal arts college with class sizes averaging about 24 students with approximately 12 students per laboratory section, but is appropriate for larger settings as well. As sophomores, most of the roughly 120 students who took part in the project in the last three years are not yet experienced with independent, critical thinking skills in a laboratory setting. They have taken a one semester introductory biology course, at least one semester of general chemistry, and sometimes have completed Genetics. In the sophomore level CMB course, we had two major concerns. First, when the course was initially designed, laboratory time was used primarily as a way to introduce techniques and classroom time emphasized content knowledge. With new instructors in the last several years, the course emphasis has been placed on helping students further their critical thinking skills through problem-solving, discussion, speculation about relationships, and reasoning. The laboratory portion of the course was lagging behind in those changes, still using primarily "cookbook" style labs. Second, students seemed to find CMB to be particularly difficult, apparently because it, along with Genetics, was the first course they encountered that required them to integrate mathematics, chemistry and biology. They also needed to use their imagination as they speculated about dynamic cells and molecules that are too small for them to see. The laboratory portion of the course needed to be redesigned to help develop scientific thinking skills and to help students grasp the dynamic nature of living cells.

The specific goal of the project described here was to provide more opportunity for critical analysis, creativity, and independent thought during the CMB laboratory through the use of student-designed experiments with cultured cells. For overviews of reasoning behind the need to involve students in active, inquiry-based science projects as undergraduates, see National Research Council, 2003 and Rothman and Narum, 1999. In addition, we wanted to help students understand that cells are dynamic entities by working with living cells and to develop meticulous laboratory habits through the use of sterile technique and repeated
measures. The focus of the project was on the process of doing science in addition to learning content and techniques. Student research teams (see Wright and Boggs, 2002 for another approach to team learning in cell biology) were asked to come up with their own question, design experiments to answer their question, and then report their results to peers and faculty either as a scientific poster or paper. The only given was the mouse fibroblast cell culture model system.

We asked the following questions during the laboratory modification: Is it feasible to permit undergraduate students with no previous experience using cell cultures the opportunity to design and carry out their own cell culture experiments as part of a sophomore level core course in biology? Does the open-endedness of an inquiry-based cell culture laboratory put more responsibility on students to think about what they are doing and thus foster greater autonomy and better learning? In addition we asked: Do students have a better concept of cells as dynamic entities after working with cultured cells for several weeks? We will discuss the feasibility through an analysis of the time and costs involved. Data on attitudes and concepts of cell function were gathered through student surveys administered early and late in the semester as well as through our personal observations (see Angelo and Cross, 1993).

Methods

Overview

The cell culture project is incorporated into the semester beginning sometime between the fourth and eighth weeks of the thirteen week term. At that point, the students have discussed basic cell function, organelles, and the structure and synthesis of the major macromolecules. We are usually beginning to study membrane structure and function at this point in the term and have not yet gotten to the details of cellular respiration or to molecular processing and transport within cells. Working in groups of two to four students, the research groups are taught sterile technique, cell splitting, and counting (for instructional details, please e-mail the author). The groups are then asked to care for and observe their cells for about a week, during which time they should be discussing various options for research questions. Each group must present a short research proposal to the professor that includes a hypothesis, the reasoning behind that hypothesis, an overview of the data collection plans, a predicted outcome, and a list of needed supplies beyond those available to all members of the class. The students are then given three weeks to complete their project. Results are presented either in the form of a laboratory report or a poster.

Student Projects

As they consider their individual projects, most student groups discuss various ideas with the professors beforehand. We try to point out if a project is too ambitious or costly to carry out within the constraints of the class, if the students have a serious lack of control in the proposed experiment, or if the students have not considered how they will collect and analyze the data to draw reasonable conclusions. The greatest challenge is overly ambitious ideas, but we remind students that they have only three weeks to complete the project and that this is just one of the classes they are taking. Students also often need reminders that anything added to the medium must be sterile. By one week after the initial instructional laboratory session, each student group must turn in a short written proposal documenting their plans. That proposal includes a hypothesis and the reasoning behind that hypothesis, a list of any supplies needed including the source and cost, a summary of the research techniques including the number of flasks or wells to be repeated for each point in the dataset, what data will be gathered (visual observations, cell counts, viable cell counts, or some other variable), and predicted results, preferably in graphic form. The laboratory assistant helps the students in looking up items in biological and chemical supply catalogs and orders the things they have requested upon approval by the instructor.

During the three weeks of the project, no other formal laboratory sessions are held. Students frequently ask for assistance in determining if their cell cultures have become contaminated, in making and sterilizing things they wish to add to the medium, in determining how to use the 24 well plates, etc. Occasionally, a student group contaminates their cultures. The instructor splits a backup set of cells every few days to have a new stock available in those cases. The instructors and laboratory assistant also monitor how well the students are doing at keeping the work areas clean and whether more disposable supplies are needed. Our greatest challenges have been students failing to clean and put away the hemocytometers and students
trying to keep all of their cells when splitting rather than just keeping a few flasks for use (ending up with as many as 20 flasks in the incubator).

Assessment

One concern students often have is “How will I be graded?” We try to be clear with our students that we are grading them on a variety of factors, but whether they get the “right” answer from their experiment is not one of them. We do assess our students’ group interaction, cooperation, and effort through a combination of our own observation and student surveys given later in the term. We also grade them on their experimental design and techniques, looking for an answerable but creative question, good controls, repetition, and a logical approach to data analysis. Finally, we grade them on their ability to present the results and how the results of their small experiment would modify how they approached the same question again and would generalize to broader issues in cell biology. See Walvoord and Anderson, 1998 and Allen and Tanner, 2006 for discussions of the development of grading rubrics. The grading rubrics used for poster and laboratory report presentations are included in Appendix A.

In addition, we wanted to assess whether the cell culture project was achieving the goals we had for it as laid out in the introduction. We administered an eleven question Likert scale survey to the students before and after the project (Appendix B) during three semesters. We conducted one tailed Mann-Whitney U tests (Avery, 2007) on before and after Likert data. These data give an indication of student opinions about their learning and confidence.

Supplies

Table 1 lists the major supplies used for the cell culture project, including vendors, catalog numbers, and cost estimates. The total cost of running the cell culture project for about 24 students in one semester is approximately $1500. Other items used that are assumed to be readily available in the laboratory are a funnel and flask for the disposal of liquid wastes, microscopes for counting cells using the hemocytometer, a 37° degree incubator with 5% oxygen and 95% carbon dioxide, micropipetors and tips, test tube and microfuge tube racks, an inverted microscope for viewing the cells in their flasks, sodium chloride, sodium phosphate, sodium bicarbonate, potassium chloride, potassium phosphate, distilled water, balances, stir bars, flasks, a pH probe, an autoclave, and sterile media bottles. Details for making the solutions are available from the authors.

<table>
<thead>
<tr>
<th>Product</th>
<th>Use</th>
<th>Size</th>
<th>Vendor</th>
<th>Cost estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disposable lab coats</td>
<td>Worn whenever working with cells and left in the lab</td>
<td>Various; 30/box</td>
<td>VWR (80076-732)</td>
<td>$154</td>
</tr>
<tr>
<td>Gloves</td>
<td>Worn whenever working with cells or chemicals</td>
<td>Various</td>
<td>Dash; 100/box</td>
<td>$4</td>
</tr>
<tr>
<td>Cidecon</td>
<td>Disinfection of lab surfaces</td>
<td>1 gallon</td>
<td>Fisher (04-355-64)</td>
<td>$30</td>
</tr>
<tr>
<td>Nonsterile gauze sponge</td>
<td>To line a funnel for a liquid waste disposal flask</td>
<td>4000/box</td>
<td>Fisher (22-415-496)</td>
<td>$71</td>
</tr>
<tr>
<td>McCoy’s medium</td>
<td>For growing cells</td>
<td>1 liter (10X concentration)</td>
<td>Sigma (M4892)</td>
<td>$30</td>
</tr>
<tr>
<td>Newborn calf serum</td>
<td>Added to the medium</td>
<td>100 ml</td>
<td>Sigma (T8154)</td>
<td>$16</td>
</tr>
<tr>
<td>Pen/Strep solution</td>
<td>Added to the medium and trypsin to kill bacteria</td>
<td>Stabilized; 10,000 units Penicillin; 10mg Streptomycin; 6 x 100 ml</td>
<td>VWR (45000-652)</td>
<td>$67</td>
</tr>
<tr>
<td>Trypsin</td>
<td>To loosen cells from the flask</td>
<td>10 g</td>
<td>Sigma (T4799)</td>
<td>$53</td>
</tr>
<tr>
<td>EDTA</td>
<td>Added to the trypsin</td>
<td>Tetrasodium salt; 100 g</td>
<td>Sigma (ED45)</td>
<td>$26</td>
</tr>
<tr>
<td>Culture flasks</td>
<td>Cell growth</td>
<td>25 ml and 50 ml; 100 per case</td>
<td>Fischer (08-772-1E and 10-126-9)</td>
<td>$135</td>
</tr>
<tr>
<td>24 well plates</td>
<td>Cell growth</td>
<td>100/case</td>
<td>ISC Bio (T-3026-1)</td>
<td>$79</td>
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<tr>
<td>Conical tubes</td>
<td>Alloquots of solutions for student use</td>
<td>15 ml (700/case) and 50 ml (500 per case)</td>
<td>ISC Bio (C-3317-2W and C-3317-3)</td>
<td>$89</td>
</tr>
<tr>
<td>Glass pipets (sterile)</td>
<td>Measurement of solutions</td>
<td>1 ml (500/pkg), 5 ml (250/pkg), 10 ml (200/pkg)</td>
<td>ISC Bio (P2830-1, P2830-5, P2830-10)</td>
<td>$53, $42, $37</td>
</tr>
<tr>
<td>Microfuge tubes</td>
<td>Alloquots of trypsin blue and cells solutions</td>
<td>500/pkg</td>
<td>ISC Bio (C-3269-1)</td>
<td>$9</td>
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<tr>
<td>Hemocytometer</td>
<td>Cell counting</td>
<td>1 slide with coverslip</td>
<td>VWR (48300-476)</td>
<td>$82</td>
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<tr>
<td>Hemocytometer cover slips</td>
<td>Cell counting</td>
<td>12/pkg</td>
<td>VWR (15170-321)</td>
<td>$29</td>
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<tr>
<td>Trypan blue</td>
<td>Determining cell viability</td>
<td>100 ml</td>
<td>Sigma (T8154)</td>
<td>$11</td>
</tr>
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</table>
Results

Student projects

Students have tried a variety of projects since the inception of the cell culture labs. Examples include variations in the amount of time cells are exposed to trypsin, variations in the temperature of the trypsin, various dilutions of the medium with PBS, and variations in incubation temperature. The latter can be quite challenging since we have only one incubator which is kept at 37°C. To try other temperatures, students must also consider gas concentrations, thus realizing that they are manipulating more than one variable. Other students have tried exposing cells to ultraviolet light of various intensities and durations. Many students like to try adding something to the medium. Examples include additional glucose, chemicals known to solubilize membranes, proteinases, salts, and viruses. One group even tried incubating the cells in various dilutions of Gatorade™. With these projects, most student groups confront several experimental design challenges. These include framing a simple, clear question, the use of proper controls, determining a method for data gathering that will be consistent for all group members, determining how to analyze data in such a way that it will answer the question asked, and considering how to manage their time to gather truly reliable results.

Assessment of student attitudes and learning

Although the results were all statistically significant, it was somewhat difficult to measure changes in student perception about confidence and learning through the attitude survey we administered because the students showed great confidence in themselves and their knowledge even before they began the project. That confidence and knowledge is not particularly consistent with our informal observations based on classroom discussions, test results, and discussions with the students during office hours. Transylvania students, however, were often some of the best students in their high school classes, so they tend to enter college with a rather high level of self-esteem.

The combined results from the attitude surveys given in the winter and fall terms of 2005 and the winter term of 2007 to 58 students are shown in Table 2. P values from one-tailed Mann-Whitney U tests done before and after Likert data are shown in the last column. The exact questions asked are shown in Appendix B. The results indicate that despite mild anxiety to begin with, most students were glad they had the opportunity to work with the cell cultures (Question 11). They also show that they felt like they were involved in the scientific process (Question 8) and that the project helped them understand the interactions of cells (Question 3). They also indicated that students felt more confident in their experimental design abilities (Questions 4 and 10) and that they felt like they had developed skills through repetition (Question 5). Finally, the results indicate that students felt that the lab project helped them understand concepts and relationships presented throughout the course (Questions 2 and 9).

Table 2. Average Likert scale scores from the student survey (n=58).

<table>
<thead>
<tr>
<th>Question</th>
<th>Pre-lab survey</th>
<th>Post-lab survey</th>
<th>Difference</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Visual image</td>
<td>4.28</td>
<td>4.09</td>
<td>0.14</td>
<td>.0037</td>
</tr>
<tr>
<td>2. Concept understanding</td>
<td>3.91</td>
<td>4.25</td>
<td>0.34</td>
<td>.0123</td>
</tr>
<tr>
<td>3. Cell interaction</td>
<td>3.81</td>
<td>4.46</td>
<td>0.65</td>
<td>.0000</td>
</tr>
<tr>
<td>4. Experimental design</td>
<td>3.53</td>
<td>4.12</td>
<td>0.59</td>
<td>.0002</td>
</tr>
<tr>
<td>5. Repetition</td>
<td>3.37</td>
<td>4.25</td>
<td>0.88</td>
<td>.0004</td>
</tr>
<tr>
<td>6. Time and groups</td>
<td>4.24</td>
<td>4.59</td>
<td>0.35</td>
<td>.0028</td>
</tr>
<tr>
<td>7. Decision making</td>
<td>3.88</td>
<td>4.27</td>
<td>0.39</td>
<td>.0123</td>
</tr>
<tr>
<td>8. Risk</td>
<td>3.67</td>
<td>4.56</td>
<td>0.89</td>
<td>.0000</td>
</tr>
<tr>
<td>9. Relationships</td>
<td>3.78</td>
<td>4.39</td>
<td>0.61</td>
<td>.0000</td>
</tr>
<tr>
<td>10. Outlook on independence</td>
<td>3.57</td>
<td>4.19</td>
<td>0.63</td>
<td>.0010</td>
</tr>
<tr>
<td>11. Anxiety/Gladness</td>
<td>3.90</td>
<td>4.19</td>
<td>0.29</td>
<td>.0413</td>
</tr>
</tbody>
</table>

The students ranked themselves amazingly high on time management and group interaction skills before beginning the project (Question 6), something the professors would have ranked quite low. Despite the high starting perception, students felt that their skills improved during the project. The professors noted many groups struggling with time management, work allocation, and responsibility during the project. With this and the many other
group projects that are included throughout a Transylvania education, informal observation of the faculty would indicate a large improvement in these skills throughout their college experience. Given the many mistakes that the groups made and learned from, it is pleasing to note that student confidence in their decision making ability rose significantly during the project (Question 7). In fact, this project showed many students that they had overestimated their initial abilities.

Question 1 addressed one of our central goals for this project, helping students understand cells as dynamic entities. In addition to the survey results, informal observations of the professors are consistent with an improvement in this aspect cell biology. In the discussions students had with us while studying for exams and while discussing their projects, we noticed more students considering cells as changing, dynamic entities than before we began the project. In responses to open-ended questions accompanying the survey given after the project, students often indicated that they had learned a great deal about time management, independent learning, and group interaction skills. The following is one student’s analysis of the experience.

I enjoyed this lab. It allowed us to apply the knowledge we have gained about the nature of cells to design our own experiment. This knowledge gave us better understanding of what occurred in our experiment. This lab made us think about what we were doing and understand it. We weren’t given a road map. Typically in labs we get step-by-step instructions of procedures so it’s easy to thoughtlessly follow directions. With this lab, the instructions were our own; therefore, we had to understand why and how every step was to be taken. We learned responsibility in this lab. We learned to rely on each other. We visited the lab every day and 99% of the time, it was all three of us, each with a different task to complete. We alternated each time so everyone got to learn new lab skills and hands on experience. Work in the hood made us consider every potential source of contamination and take extreme care in avoiding it. Everything we did was carefully monitored and done with precision, so as to avoid mistakes and contamination. We had to absolutely focus on every move. This lab gave us many new skills and much more careful and precise technique. Learning to use hemocytometers was amazing.

[Unreadable section] This has probably been the most interesting, valuable, meaningful, tedious, long, informative lab I’ve ever done. I would love to do it over. As I look back, it is amazing how much we have all learned from it.

As this above passage indicates, to gather better data on such the cell culture project’s impact on attitudes and learning, it would probably be a good idea to conduct interviews of students before and after the experience.

Challenges

Another observation made by the professors is that many students struggled with considering the role of controls and repeats in experimental design. Their initial proposals often included confounding variables that they were not even aware of. In addition, they often failed to consider the importance of staggering times of well set-up to prepare for the time needed for data gathering at the end. In other words, they would start many wells at the identical time, but then discover that counting cells took many hours. Therefore, some wells had incubated for much longer than others.

The presentation of the project in the form of a poster or written report revealed many experimental errors to the students. They often indicated a desire to have more time during the term to repeat the experiment more carefully. Although more time was not available during CMB class, Transylvania biology students get many more opportunities to do independent projects in later classes, so the impact of this learning experience is seen in other settings.

During one semester, one of the professors who supports this project was on sabbatical and the other had part-time administrative duties which often required her to be out of the building. During that semester, some students indicated frustration with lack of access to an “expert” to consult when a problem arose. Based on that experience, we would recommend that this project be undertaken when the professor and/or laboratory assistant can have a high level of visibility to students throughout the term.

Discussion

In summary, students seem to benefit greatly from inclusion of the cell culture project in CMB. Their ability to manage time, design experiments, work with a group, and imagine cells as dynamic, interactive entities appears to improve. In addition, most students report that they enjoy the independence of asking their own questions. There are, of course, a few
exceptions. Some students prefer a more “cookbook” approach because it is simpler, takes less time, and does not require that they depend on others. Students who have traditionally gotten very high grades by working alone and in a more regimented fashion sometimes find the cell culture project uncomfortable. The project does require some intense time by both the professors and the laboratory technical assistant, particularly during the training sessions, but the cost is not prohibitive and the benefits seem to be high.

We began this project in an attempt to more actively engage sophomore level students the scientific process as a part of CMB class. In doing so, we asked whether it is feasible to permit undergraduate students with no previous experience using cell cultures the opportunity to design and carry out their own cell culture experiments as part of a sophomore level core course in biology. The answer to that is clearly affirmative. The time and money expenses invested are not unreasonable. The most expensive items are a laminar flow hood, which we have shown is not essential, and an incubator. Disposable supplies are not insignificant, but are reasonable (less than $75 per student). One of the greatest challenges was getting the students to work with 24 well plates for their experiments after teaching them the techniques using flasks. In the future, we plan to try to teach the students to observe and split cells directly in the 24 well plates rather than ever working with flasks.

In addition, we asked whether the open-endedness of an inquiry-based cell culture laboratory put more responsibility on students to think about what they are doing and thus foster greater autonomy and better learning. We also asked if students got a better concept of cells as dynamic entities after working with the cell cultures. Survey results seem to indicate that the answers to these questions are also affirmative. Our informal observations definitely indicate greater autonomy and responsibility on the part of the students. To further foster student learning, we would like to more strongly link the cell culture project with many of the subjects discussed in a CMB class. For example, how could the cells be used to specifically study membrane transport? Could they be used to study respiration, energetics, or organelle function? Could their structure be examined through microscopic techniques? If the model system was used not only by the students in one project of their own design, but also in other experiments designed by the professors, it might assist the students even more in demonstrating relationships between cell structure and function.

In conclusion, we recommend that others try working with cultured cells early in a biology education for undergraduate students. This model system provides an opportunity for students to gain a variety of scientific skills and to have fun doing so. It can provide a foundation for further class-based research projects as students advance through the major.

Acknowledgments

We wish to thank Joni Wiseman, the Transylvania laboratory technical assistant, for her tireless efforts in support of this and many other projects. She handled all of the ordering, prepared all of the solutions, taught the students sterile technique, and answered endless questions from both students and professors as each student project was implemented. Sunny Saclinger kindly sent the gift of a fresh supply of fibroblast cells each term, saving us having to maintain our own cultures between terms. FIRST II provided the impetus and guidelines for preparation of this manuscript. Detailed information on instructions given to students and solution recipes are available by contacting Peggy Shadduck Palombi at ppalombi@transy.edu.
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Alu Insertions and Genetic Diversity: A Preliminary Investigation by an Undergraduate Bioinformatics Class


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Abstract: Alu-insertion polymorphisms were used by an undergraduate Bioinformatics class to study how these insertion sites could be the basis for an investigation in human population genetics. Based on the students’ investigation, both allele and genotype Alu frequencies were determined for African-American and Japanese populations as well as a control. The three populations were tested for the presence of Alu-insertions on the 4th, 10th and 16th chromosomes.

Keywords: bioinformatics, Alu insertions, SINES

Introduction

Alu elements, short interspersed elements (SINES) have been gathering within the human genome throughout the evolution of primates. Alu elements belong to a larger group of mobile elements which comprise over 45% of our DNA (Batzner & Deininger, 2002). They are selfish pieces of DNA in that they don’t encode for any proteins, they freely replicate and finally insert themselves into new chromosomal locations. These “jumping genes” are also known as transposable DNA [transposons] and were once studied in corn by Nobel Laureate, Barbara McClintock. Alu elements are specific to the primate genome and appeared roughly 65 million years ago (Carroll et al., 2001). With all of the replicating and raiding of chromosomes through insertions, Alu elements make up the largest of the SINES within humans; reaching over 1 million copies per genome and making up ~10% of the genome (Roy-Engel et al., 2001, Carroll et al., 2001). However this being said, it should be made clear that not all Alu insertions are the same. Once an Alu element becomes ‘comfortable’ in a new location, it starts to collect new mutations at the same pace as the surrounding DNA. Based on these new mutations, Alu elements are separated and organized into distinct lineages built on inheritance patterns. Since each Alu insertion is secure over evolution it is inherited by basic Mendelian genetics from parent to offspring. Consequently all individuals having an Alu insertion at a specific locus share a common ancestor from which they inherited the fragment. As a result, many of these Alu insertion sites are considered “landmarks” in the evolution of the human genome (Smit, 1996; Deininger & Batzer, 1999). Considering these factors, it was felt that the Alu-insertion polymorphisms would be an ideal topic of investigation in human population genetics for an undergraduate bioinformatics course. It was the intent of these bioinformatics’ students to find differences in both the allele and genotype Alu frequencies by comparing two distinct ethnic populations (Japanese and African American) against a control. This was accomplished by using three different primers to detect specific Alu insertions on the 4th, 10th, and 16th chromosomes (Figure 1). Here, we present an analysis of our findings for these populations using Alu insertions.

Figure 1. Alu Insertion Sites on Chromosomes 4, 10 and 16. Arrows represent the approximate location of the Alu insertion on the respective chromosomes (National Center for Biotechnology Information). Figure generated by Nancy L. Elwess.
Methods and Materials

DNA Isolation Procedures (modified from the DNA Dolan Learning Center)

The students had the task of collecting over 60 DNA samples, this included ~20 samples from the control group; and each of the test groups (Japanese and African-American). The student investigators collected the samples from students on campus. Prior to the collection of samples, one liter of a 0.9% saline solution was made (9 grams of NaCl/1000 mL dH2O). 10 mL 0.9% saline solution was aliquoted into 50 mL polypropylene tubes.

To summarize the Dolan DNA Learning Center procedures, participants in this investigation were asked to swish 10 mL of 0.9% saline solution for approximately 30 seconds in their mouths, this was collected. In addition they were asked to sign a consent form. From each sample, one milliliter of the saliva-saline solution was placed into a 1.5 mL screw cap microcentrifuge tube and labeled with a number in order to identify the participant. The samples were concentrated for 1 minute at 12,000 rpm. A white pellet (containing cheek cells) resulted. The supernatant was removed and the pellet resuspended in 30 µL of saline solution.

To each resuspended sample 100 µL of 10% Chelex® was added. All the samples were placed in a boiling water bath for 10 minutes. The sample tubes were cooled on ice and spun for one minute at 12,000 rpm in a microcentrifuge. This step separated the DNA from the cellular debris. 30 µL of the top layer of supernatant from each sample tube was collected and transferred into a fresh 1.5 mL tube with the corresponding number, the resulting samples of DNA were used for the Polymerase Chain Reactions (PCR). The samples were stored on ice or placed in the freezer until they were needed for the PCR reactions.

DNA Amplification using Polymerase Chain Reaction

Reagents

Alu specific primers (Table 1) were ordered through Integrated DNA Technologies (IDT), each primer was diluted to a working concentration of 20 µM. The primers were designed to target regions upstream and downstream of a specific Alu insertion site. Each Alu fragment is approximately 300 base pairs in length. For example if there is no Alu insertion for Yb9NBC10 the size of the PCR product will be 197 base pairs, however if an Alu insertion is present the PCR product will be 524 base pairs for that primer.

<table>
<thead>
<tr>
<th>Name</th>
<th>Primer Sequence</th>
<th>Chromosome Location</th>
<th>Human Diversity</th>
<th>Product Size (bp) With</th>
<th>Product Size (bp) Without</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yb9NBC10F</td>
<td>5' GTT TTC CTG GTG TGC CCT AAT TA-3'</td>
<td>4</td>
<td>IF</td>
<td>524</td>
<td>197</td>
</tr>
<tr>
<td>Yb9NBC10R</td>
<td>5' TTT ACC TAA CTC ACA AGA CCC AAA G-3'</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ye1NBC60F</td>
<td>5' GAAACCGCCAAGATTCTCACC -3'</td>
<td>10</td>
<td>IF</td>
<td>522</td>
<td>205</td>
</tr>
<tr>
<td>Ye1NBC60R</td>
<td>5' TCTCCATCATGATTTCCACAACTGA-3'</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1. Primer sequences: Primer sequences for the three sets of Alu elements that were targeted for this study. Human diversity is classified as: High Frequency (HF) insertion polymorphism where the Alu element is present in all individuals tested except for one or two; Intermediate Frequency (IF) insertion polymorphism: the Alu element is present or absent in at least one population. We did not use any Low Frequency (LF) Alu insertion polymorphisms: these are Alu elements which are absent from all individuals tested except for one or two individuals.
Procedures

Ready-to-Go PCR® tubes (GE Healthcare) were numbered with the corresponding sample numbers. To each tube, 17.5 ul of sterile dH2O was added along with 2.5 ul of the desired forward and reverse primers for a specific Alu locus. Finally, 2.5 ul of each DNA sample was added to the corresponding numbered tube. The total final volume for each Ready-to-Go PCR® tube was 25 ul (17.5 ul of sterile dH2O, 2.5 ul of each primer and 2.5 ul of DNA). Each sample tube was overlaid with 50 ul of mineral oil (since the thermal cycler did not have a heated lid) and added to the thermal cycler.

The thermal cycler was programmed for 30 cycles for the following cycle:
- Denaturing temperature and time: 94°C for 30 seconds
- Annealing temperature and time: 68°C for 30 seconds
- Extension temperature and time: 72°C for 30 seconds

DNA Gel Electrophoresis

20 ul of the amplified sample was retrieved from under the mineral oil for each sample and expelled into a new, labeled microcentrifuge tube containing 3 ul of loading dye. Each sample was loaded into a well on a 2% agarose gel (which contained 10 ul of 100 mg/mL ethidium bromide per 50 mL volume agarose). One lane was reserved for the 100 base pair ladder. Following electrophoresis, images of the gel were captured using a UV light box and a Kodak gel documentation system, then interpreted (Figure 2).

Figure 2. A 2% agarose gel containing a 100 base pair standard (Lane 1) and six Japanese DNA samples (lanes 2-7) that were amplified with the Yc1NBC60 primers targeting chromosome 10. If the Alu insertion was present, a 522 base pair (bp) product was produced. If the Alu insertion was not present, then a 205 bp product was produced. Lanes 2, 5, and 7 contained the 10th chromosome's Alu target with the insertion and the 10th chromosome's Alu target without the insertion (+/-), hence the presence of two different sized bands. Lanes 3, 4 and 6, with only one band, designate these individuals as having the presence of two insertions (+/+) for the targeted Alu area.

Results

In this experiment the frequency of specific Alu insertions within different ethnicity groups were compared. Japanese and African-American groups were compared to the control group of random individuals for Alu insertions on the 4th, 10th and 16th chromosomes using the primers Yb9NBC10, YcNBC60 and PV-92 respectively. Table 2 shows the results for the genotype frequencies for each group and for each of the tested chromosome sites. If the insertion was present on both chromosomes, the individual was +/-; if the individual had one insertion on a chromosome and none on the homologous chromosome, then that person was +/- finally, if no insertions were found on either chromosome then the person was -/-. 
Table 2. Genotype frequencies; Genotype frequencies for the two test groups and the control group for the 4th, 10th, and 16th chromosomes. +/+ represents Alu insertions are present on both of the targeted chromosomes; +/- represents an Alu insertion is present on one of the targeted chromosomes; -/- represents that no Alu insertions are present for the targeted chromosomes.

<table>
<thead>
<tr>
<th>Chromosome</th>
<th>Control</th>
<th>African-American</th>
<th>Japanese</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>+/+</td>
<td>+/-</td>
<td>-/-</td>
</tr>
<tr>
<td>4th</td>
<td>0%</td>
<td>18%</td>
<td>82%</td>
</tr>
<tr>
<td></td>
<td>+/+</td>
<td>0%</td>
<td>29%</td>
</tr>
<tr>
<td></td>
<td>+/-</td>
<td>33%</td>
<td>27%</td>
</tr>
<tr>
<td></td>
<td>-/-</td>
<td>0%</td>
<td>12.5%</td>
</tr>
<tr>
<td>10th</td>
<td>68%</td>
<td>14%</td>
<td>18%</td>
</tr>
<tr>
<td></td>
<td>+/+</td>
<td>55%</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>+/-</td>
<td>56%</td>
<td>36%</td>
</tr>
<tr>
<td></td>
<td>-/-</td>
<td>56%</td>
<td>13%</td>
</tr>
</tbody>
</table>

The biggest differences that were seen for the genotype frequencies occurred on chromosomes 10 and 16. On chromosome 10, the majority of the Control group and Japanese groups had +/+ (68% and 56% respectively) compared to the African-American test groups with only 33% +/+. The Japanese test group did show differences from the Control and African-American groups for the 16th chromosome. The majority of the Japanese had +/+ (56%) while the Control and African-American groups had 7% and 0% respectively for +/+.

Figures 3-5 provide the results for the allele frequencies for the targeted 4th, 10th and 16th chromosome Alu insertion sites. The allele frequency was determined by comparing the number of copies for a specific allele to the total number of alleles present. For example if the results had 10 +/+ individuals, 5 +/- individuals and 5 -/- individuals, the allele frequency would have a total of 25 + (insertions) and 15 - (no insertions). This would result in a 62.5% + and 37.5% - allele frequency. There was not that big of a difference in allele frequency between the three groups for chromosome 4 (Figure 3). However, there were differences in allele frequencies on Chromosome 10 for the African-American group (Figure 4) and on Chromosome 16 for the Japanese test group (Figure 5).

Figure 4. Distribution of allele frequencies for Alu insertions on the 10th chromosome.

Discussion

Comparisons to data from past research and the literature can also be drawn from this experiment. For example, the Dolan DNA Learning Center (www.geneticorgins.org) provides a database of allele and genotype frequencies for the PV-92 Alu insertion (on the 16th chromosome) from over 40 populations around the world. According to the database the African-American allele frequency for this Alu insertion was 20%, whereas only 6% of our African-American test group had this insertion present. However, this discrepancy in the data may be due to the small population size for not only our study (21 samples) but also in the Dolan DNA Learning Center database (42 samples). More sampling using the African-American population, needs to be done to establish a reliable set of data.

The Dolan DNA Learning Center database and other sources did not have any data on the frequencies of the PV-92 Alu insertions in the Japanese population. So whatever data we could provide added to the knowledge in the field. However, the Japanese population was compared to other Asian
populations, which were known to have a high et al., 2001). There was a 90% + allele frequency for the Taiwanese population, 86% for the Chinese, 80% for the Filipino population as compared to the 62.5% + allele frequency in our Japanese test group.

Figure 5. Distribution of allele frequencies for $Alu$ insertions on the 16th chromosome.

Further comparisons were made to published results of the Yb9NBC10 (Chromosome 4) and Yc1NBC60 (Chromosome 10) $Alu$ elements (Roy-Engel et al., 2001). According to the published results the African-American test group had 37.5% +/+, 12.5% +/-, and 50% -/- for the Yb9NBC10 $Alu$ element this frequency of the $Alu$ insertion at this site (Comas was different from our results of 0% +/+, 29% +/-, and 71% -/-. It should be noted, however, that the Roy-Engel et al. article (2001) findings were based on only 8 samples compared to our 21 samples. When comparisons for the African-American populations were made concerning the Yc1NBC60 $Alu$ element between the Roy-Engel paper and our study, there were once again differences. We had 33% +/+, 27% +/-, and 40% -/- for our African-American samples compared to their results of 33.33% +/+, 50% +/-, and 16.66% -/-. Here again the Roy-Engel paper had a smaller sample size then our study.

We could not make these direct comparisons for our Japanese results. The only published results that were close were for Asian/Alaska natives. This made our findings even more exciting due to no other published results for a Japanese test group.

Finally, in addition to our $Alu$ findings, the bioinformatics students researched and presented findings from journal articles about genetic disorders/diseases that happen as a result of an $Alu$ insertion within a gene. If time had allowed, we would have added more populations to sample and additional $Alu$ locations to study.

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Charting a New Direction: Results of the ACUBE Member Survey

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Abstract: The ACUBE Steering Committee and President conducted an online survey of members from November 2007-January 2008. The survey asked members for input on a variety of issues facing ACUBE, ranging from participation in the association to satisfaction with annual meetings, Bioscience, and the webpage. The survey was completed by 34% of the membership resulting in 34 pages of data and comments. A preliminary report was delivered at the 2008 Annual Meeting at Hopkinsville Community College; this document is intended to provide more details about the results and inform members who were unable to attend the annual meeting. Based on the results of the survey, the Steering Committee has approved four goals for a still developing Strategic Plan for ACUBE. The Strategic Plan is a work in progress and will rely heavily on results from the member survey. This report provides a suggestion of where ACUBE may be headed in the future as that Plan continues to develop.

Keywords: ACUBE, survey, strategic plan

Introduction

The Association for College and University Biology Educators (ACUBE) has benefited from a dedicated membership committed to promoting biology education as demonstrated by the 50th anniversary of the society in 2007. In 1957 there were 44 members from 11 Midwestern states. In 1997 the name of the society was changed from the Association of Midwest College and Biology Teachers to its current name as a reflection of the growing national membership. In 1998 the society had grown to 340 members from 30 states. Today there are 270 active members who are diverse in many ways, including: stage of career, type of institution employed at, field of biology trained in. However, the membership of the society is a very small portion of the estimated 65,000 biologists who teach at post-secondary institutions in the United States (Bureau of Labor Statistics, 2008). While ACUBE has never sought to capture all biology educators as part of its membership, or to be the largest biology related society, it does seek to serve its constituency through the following objectives as stated in the constitution of the organization:

1) To further the teaching of the biological sciences at the college and other levels of educational experience;

2) To bring to light common problems involving biological curricula at the college level and by the free interchange of ideas; endeavor to resolve these problems;

3) To encourage active participation in biological research by teachers and students in the belief that such participation is an invaluable adjunct to effective teaching;

4) To create a voice which will be effective in bringing the collective views of the college and university teachers of the biological sciences to the attention of college and civil government administrations.

As ACUBE enters its second 50 years, the society is facing many questions about the future of the society, as outlined by current ACUBE President, Conrad Toepfer, in his letter published in Bioscience in December 2007. These issues include maintaining and increasing membership and increasing the impact of ACUBE in biology education. The steering committee led small-group discussions of these issues over lunch at the annual meeting at Loras College in October 2007. From these initial discussions, a decision was made to collect more feedback from the society. This article is a summary of the results from that survey, and reflections from the steering committee of ACUBE about priorities for the next few years to meet the expectations of the members and the goals of the organization. A link to the electronic survey was sent to all members in November 2007. The anonymous
survey was available for six weeks, and a reminder was sent to all members in December 2007. Thirty-four percent of the ACUBE members completed the 27-question survey.

Results

Information on Survey Respondents:

Forty-one percent of survey respondents have been members for less than five years. Thirty-four percent of those who participated in the survey have been members for over ten years. Even with a large number of respondents who have been members for a significant length of time, only 10% of respondents have been to four or five annual ACUBE meetings in the last five years. Almost 40% of respondents have not been to any ACUBE annual meetings in the last five years. Sixty-four percent of survey respondents indicate that they are in a tenure-track or tenured position at a college or university. Other job titles included: retired (15%), full-time instructor (8%), adjunct or part-time instructor (2%), graduate student or post-doc (2%), or other (9%). The job titles in the “other” category included administrators (or part-time administrators), librarians, and limited-term professors. Sixteen percent have served on the Bioscene editorial board.

Figure 1. Factors determining attendance at the ACUBE annual meeting. The survey question asked: “Which of the following is an important factor in your decision to attend the ACUBE annual meeting?” (select all that apply)

Overwhelmingly, 90% of members agree that 45-minute talks at the annual meeting is an effective presentation type. Only 15% of respondents agree that the 90-minute talks are effective. The keynote address and poster presentations were equally supported by 42% of attendees as effective presentation types. Overall, the survey respondents are supportive of trying new presentation types, including targeted workshops, panel presentations, and shorter presentations (Figure 2).

Figure 2: Suggestions for new presentation types at the ACUBE annual meeting. The survey question asked: “It has been suggested that we try new presentation types in the future at the ACUBE annual meeting. Which of the following would you find useful in delivering information (select all that apply)?”

Charting a New Direction

Bioscene 41
ACUBE members were asked to give their opinion on changes to the annual meeting including location, time of year, and methods of advertisement. These results are summarized in Table 1. Overall, the membership appears supportive of changes to the annual meeting, except altering the Thursday-Saturday schedule. Ideas that received the strongest support (in terms of percent who indicated that they agreed or strongly agreed that the following should be done to improve the annual meeting) included devoting an issue of Bioscience to the meeting theme, advertise to increase the number of people attending the meeting, announcing meeting locations two years in advance, and advertise to bring in more graduate students.

Table 1: Survey respondents were asked to give their opinions on possible changes to the annual meeting (scale ranged from strongly agree to strongly disagree). Percentages for “agreed and strongly agreed” were combined, as were “disagreed or strongly disagreed”, as shown on the below. Suggestions are ranked in descending order based on the percent of respondents who agreed with each statement.

<table>
<thead>
<tr>
<th>Possible changes to ACUBE annual meeting</th>
<th>Agree or strongly agree</th>
<th>Neutral</th>
<th>Disagree or strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Devote a Bioscience issue per year to the meeting theme, giving presenters the option of publishing</td>
<td>86</td>
<td>11</td>
<td>3</td>
</tr>
<tr>
<td>Increase advertising to increase the number of people who attend the meeting</td>
<td>85</td>
<td>11</td>
<td>4</td>
</tr>
<tr>
<td>Announce the meeting locations two years in advance</td>
<td>81</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td>Advertise to bring in more graduate students</td>
<td>80</td>
<td>12</td>
<td>8</td>
</tr>
<tr>
<td>Announce the themes for the meeting earlier in the year</td>
<td>66</td>
<td>28</td>
<td>8</td>
</tr>
<tr>
<td>Alternate meetings between large cities and small cities</td>
<td>64</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>Hold the meeting in more convenient locations near a major airport</td>
<td>62</td>
<td>27</td>
<td>11</td>
</tr>
<tr>
<td>Post a board on the website for ride sharing to the meeting</td>
<td>56</td>
<td>38</td>
<td>6</td>
</tr>
<tr>
<td>Alternate meetings on a two year cycle; regional meetings one year, national meeting the next</td>
<td>65</td>
<td>28</td>
<td>17</td>
</tr>
<tr>
<td>Offer travel funds to junior faculty</td>
<td>63</td>
<td>27</td>
<td>20</td>
</tr>
<tr>
<td>Hold meetings outside of our current range</td>
<td>48</td>
<td>20</td>
<td>32</td>
</tr>
<tr>
<td>Decrease the registration fee for first time attendees</td>
<td>46</td>
<td>25</td>
<td>17</td>
</tr>
<tr>
<td>Move meetings to larger cities</td>
<td>46</td>
<td>17</td>
<td>36</td>
</tr>
<tr>
<td>Change current Thursday-Saturday schedule</td>
<td>11</td>
<td>34</td>
<td>56</td>
</tr>
</tbody>
</table>

When asked what locations were suggested for future ACUBE meetings, there were no clear trends. Several respondents indicated that they would like the meeting in locations that are easier to get to (nearer to a major airport), however there was
also support for keeping the meetings on college campuses rather than in hotels. Several individuals ask that the meeting be held outside of the Midwest, however many suggested locations in the Midwest (Madison, Minneapolis, Kansas City were mentioned several times). Two quotes from members on how to improve the annual meeting:

- "As a first-timer, it would have been helpful to have been contacted by someone in ACUBE prior to the conference to talk about logistical concerns such as "dress code" for events, customary method of presentation, etc. Also, it would be nice to have a least one familiar person to find at the beginning of the conference. ABLE has a breakfast session on the morning of the first day for first-timers. Members of the board explain what can be expected, answer any questions, and give suggestions."
- "Discussions with colleagues are an important part of the meeting and I would like to see more opportunities for 'roundtable' discussions of various teaching topics."

Other suggestions included increasing the attendance to get more energy and new ideas, hold the meeting in conjunction with other societies some years, recruiting more post-docs to attend and hold the meeting at a different time of year (because of many conflicts in October).

ACUBE website

Thirty-five percent of survey respondents indicated that they find the ACUBE website useful. It is telling however, that 57% have not used the website recently. Members were asked to indicate what they found the most useful about the website for the society, and overwhelmingly access to Bioscene was mentioned as the most useful feature. Several others indicated that the website is useful because it is uncluttered, and easy to find information about the annual meeting. Adding a calendar of events to the website was supported by 80% of members who participated in the survey. In addition, support was present for links to related sites and employment opportunities. A "members only" area of the website was only recommended by 11% of members.

Bioscene

Two thirds of the members who participated in the survey had not submitted a paper for publication in ACUBE. Lack of time to prepare a submission was cited by 42% of the individuals as the reason they had not yet published in ACUBE. Only 7% indicated that they preferred to publish in another journal. Most members (88%) use Bioscene to get teaching ideas primarily, with 52% indicating that they use Bioscene to get information on the annual meeting. Other comments on the uses of Bioscene include: giving them to high school teachers as resources, following trends in biology education, and to keep up with the business of ACUBE.

Members were asked to indicate if they would like to see additional features in Bioscene. A section devoted to columns describing useful websites was supported by 71% of members, a section for undergraduate research articles was supported by 58%, and book reviews were supported by 53% of members. Other ideas included: having targeted issues on themes, textbook reviews and critiques, articles on industry connections, articles on grant opportunities and grant writing. Some concern was expressed about website reviews, indicating that websites are frequently changed or removed, making the article not applicable in a short time. It was suggested that this might be more suitable for an e-newsletter.

No clarity was given by the membership about the future format of Bioscene (print, online or both). Thirty four percent of members indicated that they preferred to receive Bioscene in print, 33% preferred online, and 33% preferred both formats. However, 58% of members indicated that they would be willing to get Bioscene only in an online format in exchange for other services from ACUBE (24% indicated it depended on the service offered). One suggestion was to make individuals who get paper copies pay more for their memberships. Forty-eight percent of members do not see the need to print a full run of Bioscene on a CD, however 25% said they would use the CDs to find articles, and 18% said they would give the CDs to recruit new members.

ACUBE Membership

Over 60% of members indicated that they first learned about ACUBE from a colleague, confirming the importance of networking to the organization. Twenty percent first learned about the organization through a flier. Members were asked if they agreed or disagreed with a number of ideas for increasing membership in the society. These results are summarized in Table 2. Overall, members supported networking with other societies to make sure our webpage is a resource to their members. In addition, advertising at other professional conferences and publications was thought to be useful in increasing membership. Some ideas from members on how to increase membership included:

- "Need to increase the "name brand" of the society. Needs to grow to truly be a national organization"
- "Invite high school science teachers that offer college advanced credit or advanced
- placement courses on their high school campuses"
- "Offer "departmental" memberships to promote more members of departments to participate and also offer "multi-year"
- memberships (at a slightly reduced cost) so people may be more likely to keep their membership active"

Table 2: Survey respondents were asked to give their opinions on possible strategies to increase membership. Percents for the responses “useful and very useful” were combined, as were “don’t know and no effect”, as shown on the below. Suggestions are ranked in descending order based on the percent of respondents who thought the recruiting mechanisms may be useful.

<table>
<thead>
<tr>
<th>Possible changes to ACUBE annual meeting</th>
<th>Very useful or useful</th>
<th>Not useful</th>
<th>No effect or don't know</th>
</tr>
</thead>
<tbody>
<tr>
<td>Make sure our website is listed as a link on other professional websites</td>
<td>94</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Advertise at other professional conferences</td>
<td>87</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>Recruit graduate students by contacting graduate student organizations</td>
<td>78</td>
<td>4</td>
<td>16</td>
</tr>
<tr>
<td>Encourage members to give a presentation or display information at other conferences</td>
<td>77</td>
<td>2</td>
<td>21</td>
</tr>
<tr>
<td>Develop a small ad to go into professional publications</td>
<td>74</td>
<td>6</td>
<td>20</td>
</tr>
<tr>
<td>Alternate years with regional/national meeting</td>
<td>46</td>
<td>6</td>
<td>48</td>
</tr>
<tr>
<td>Have a member recruitment contest</td>
<td>26</td>
<td>19</td>
<td>35</td>
</tr>
</tbody>
</table>

Comments from members who have been with ACUBE for over three years about how ACUBE can stay valuable during their career:

- "There isn’t a comparable society that focuses on biology education at the college level. I think the opportunities for Bioscene as a journal will keep me a member - and improvements to the annual meeting. I would like the society to really become a "national" society. Many people have never heard of ACUBE who are biology teachers."
- "The atmosphere of learning and cooperation. I feel like the annual meeting is somewhere I can go to get new ideas and get re-energized about teaching biology."
- "The pedagogical focus of annual meetings and articles in Bioscene is what I find valuable; keep that and you keep me."

All members, regardless of the time they have been part of the organization were asked which issues are critical to keep the same, and which issues/parts are critical to change. While very diverse answers were given, some themes emerged from the submissions. First, members think it is critical to keep Bioscene as part of the organization, and continue to strengthen the journal. Second, the organization needs to increase the size and expand its reputation and reach. Third, it is important to members that we keep a low cost of membership. Lastly, it is important to keep a collegial environment at the meetings and plenty of opportunities for networking. Members were asked to identify the most important issue for the organization to address in the near future. The suggestions that were
repeated the most frequently were to strengthen the size and reputation of the organization through advocacy, advertising, cooperation with other societies and continue to publish a strong journal.

**Participation in the Governance/Activities of ACUBE**

Thirty-eight percent of survey respondents indicated that they did not know enough about the governance of ACUBE to indicate if they would be willing to participate in some way. Forty percent expressed willingness to serve on the *Bioscience* editorial board. Only 19% indicated that they would be unwilling to participate in the governance of ACUBE. Time was listed at the major limiting factor for most members for getting more involved in ACUBE. Eleven percent indicated that the travel commitment (both time and funds) would prevent their participation in the governance of the organization.

**Discussion**

The strength of ACUBE since its founding as AMCBT has been the members. The expertise and creativity that we as individuals bring to our classrooms have undoubtedly influenced generations of college biology students. Participation in ACUBE either through attending the annual meeting or publishing in *Bioscience* allows each of us to continue to improve our individual skills. However, collectively we should be able to accomplish even greater things. The major themes of increasing membership, becoming advocates for education, and communicating the best teaching ideas to each other have been recurring since the founding of ACUBE over fifty years ago. Our task should be to critically examine what we are as an association and begin to plan what we want to be in the future. The membership survey was an attempt to begin a critical examination, and the Steering Committee likely will be returning to the 34 pages of data again and again in the coming months. You as members had a lot to say about the current and future state of ACUBE. The governance of ACUBE will do its best to address many of your concerns and suggestions over the course of the next year.

The member survey was organized around four themes: membership, the face of ACUBE (*Bioscience* and the webpage), the Annual Meeting, and the larger role of ACUBE in biology education. While efforts for developing a long-range Strategic Plan are in their infancy, a few events have already developed and discussions are underway to determine if and how our approach to these issues should be adjusted.

**Membership**

Membership levels in ACUBE appear to have been cyclical since our founding, and the discussion of what to do to increase membership has also been a virtual constant. The survey shows rather dramatically that most of us were recruited by colleagues. We can always work on members of our departments, but we need to always keep ACUBE in our thoughts as we participate in other venues. It is likely that all of us participate in at least one other society and attend a variety of conferences, summits, etc. where we may run into receptive peers. There can be no better advocate for the association than a satisfied member. To aid you in recruitment of your peers at other meetings one of the Steering Committee members, Tara McGinnis, developed three different recruitment posters. All three posters are available on the ACUBE website; please feel free to print them off and hand them to colleagues.

One of the potential limitations in our recruiting is visibility. The top choices in the survey involved strategies that should be relatively easy to implement. We currently are listed as a member of AIBS and have our website cross-linked with the websites for the Association for Biology Laboratory Education (www.ableweb.org) and the Association of Southeastern Biologists (www.asb.appstate.edu)...dig deep enough in their sites and you will find our association. Clearly we can do better than this. There are a number of websites that should have a link to ACUBE, an omission that should be easy to remedy.

We know that ACUBE is valuable to us either through presentations, *Bioscience* papers, or conversations over a meal at the Annual Meeting. Many members who have joined in recent years have commented that they had no idea that ACUBE existed before meeting with one of our members. Our challenge will be to make sure that even more faculty become aware of the existence of the association and recognize how valuable it is to each of us as we continue to strengthen our teaching.

**Public face**

Nonmembers of ACUBE are most likely to gain their first exposure to the association through either *Bioscience* or the website. We need to be sure that both resources continue to be high quality as they could serve as recruitment tools in addition to their continued value for members. *Bioscience* appears to serve two main purposes for members, a source of teaching ideas and providing information about the annual meeting. Both functions should be equally useful. *Bioscience* has a long tradition as a high-quality publication but various challenges with journal production will make it increasingly difficult to maintain its current quality. Some adjustments can be made fairly quickly and easily. For example, the current editor, Steve
Daggett, is open to increasing the diversity of material in the journal. Material such as letters to the editor and book reviews are encouraged and additional material is welcome. A greater challenge, however, is the rapid increases in both printing and mailing costs. In January 2008, it became clear that the organization would have difficulty covering expenses for a full 4-issue run of the journal during the year. Shifting to either partial or complete online publication brings its own challenges. The June 2008 issue of Bioscience is currently available online. For at least the next two years, Bioscience will be available only in to two issues a year with one issue published online in the early summer and a second print issue published at the end of each year.

The website is a similar bridge between members and nonmembers and could serve as a recruiting tool for the organization. Members use the site primarily for accessing information about the annual meeting and back issues of Bioscience. Both topics would be useful for nonmembers, but we do need to consider how the site appears to those not already “in the know” about our organization. Is our site compelling enough for people not already familiar with the organization? Does its appearance reflect an organization with plans for the future or one that is comfortable with the way we’ve always done things? Our website may be the first thing a prospective member sees so we should be cognizant of how it reflects the entire organization. We individually know why we joined and remained in ACUBE, are we presenting those aspects to those who are not already members?

Another continuing challenge is the difficulty of managing the site with a group of volunteers. Bobby Lee and Tim Mulkey have produced a site that is viewed as useful and easy to navigate and their dedication of their time and effort has been greatly appreciated but not always recognized. We need to begin an examination of whether we do business with the website is still viable. Many members of the organization may not be qualified to handle the technical challenges of maintaining a website. The result is that either a few very dedicated volunteers have to make long-term commitments to the organization or the turnover of volunteers results in inconsistencies in the structure and style of the website. We need to examine whether we should continue maintaining the website internally or if we should pay for the website to be maintained by an outside organization.

Annual Meeting

The annual meeting is consistently rated as one of the most valuable services provided to ACUBE members with over two-thirds of the members having been to at least one meeting. Attendance has been slowly declining for the past several years, however. For many members the decline may be because of issues such as declining professional development funds or a lack of time.

Suggestions from the membership survey were wide-ranging with many ideas that would be easy to implement immediately and many that will require extensive study before implementation. Laura Salem, the Program Chair for 2008, has already started implementing changes in the types of presentations. The 1.5 hour workshops were viewed as least useful and will likely decline over time. One of the highly rated possible additions to annual meetings has already appeared. The majority of members had favorable opinions of roundtable discussions. One roundtable discussion spontaneously developed at the 2007 Annual Meeting at Loras College, but six discussions occurred at the 2008 meeting at Hopkinsville Community College. The roundtable discussions were popular with attendees at the recent meeting and coordinators of those discussions were encouraged to submit synopses to Bioscience.

Long-term changes in the meeting will be more challenging. A discussion regarding the locations of meetings has been ongoing for several years in the Steering Committee. We have traditionally located meetings along the coasts and in the center of the core area of the membership. Having a meeting in a large city outside the Midwest has been discussed for several years within the Steering Committee. While cost has been a major concern, the idea does merit further examination. Suggestions about meeting locations that were more strongly supported in the survey will be more easily addressed. The 2008 (Hopkinsville, KY) and 2009 (Kansas City) meetings will alternate between small and large cities, a suggestion supported by over 60% of the survey respondents.

A final long-term issue that will require further study is the timing of the annual meeting. We have traditionally held the annual meeting during the fall break of the host institution. Perhaps it is time to give full consideration to holding the meeting at other times of the year. This would reduce unintentional conflicts like the conflict this year with the NABT meeting, but more importantly would allow us to consider holding joint meetings with other societies. Members have suggested holding meetings with ABLE, various state Academies of Science, or research societies such as the Southeastern Association of Naturalists. Joint meetings would have the added benefit of exposing our group to a larger pool of potential new members.

Advocacy
ACUBE is the only organization of its type, an association devoted entirely to improving biology education at the college/university level. Since this is our sole purpose, it seems like we should have a larger role in education at the national level. Going back through old issues of Bioscene and the AMCBT newsletters, it becomes clear that this has been a topic of concern for decades.

Tom Davis, Executive Secretary, and Conrad Toepfer, President, attended an educational summit in Washington, D.C., that was jointly sponsored by NSF, AAAS, and Sigma Xi. The intention of the summit was to begin a dialogue about the potential to develop a national-level biology curriculum, similar to the standards in chemistry established by the American Chemical Society. Attendees at the summit represented at least 30 different societies. While many representatives were from educational subcommittees of research-oriented societies, the only societies that were specifically focused on teaching were ACUBE and NABT. Two factors became evident during the summit: (1) ACUBE is resource-poor compared to the other societies, and (2) NABT has already spent a considerable amount of time and resources on developing a standard curriculum. While we may be able to collaborate with NABT on this particular issue, it will be difficult at this time for ACUBE to have much of a national voice. For example, one educational subcommittee of a professional society has an annual budget 2-3 times higher than ours, has paid staff, and has a $10 million endowment.

An organization such as ours depending entirely on volunteers and with a break-even annual budget will have difficulty competing for attention at events like the recent summit. While we have a valid mission, we need a serious examination of what we want to be doing in terms of education advocacy. We also need to consider our financial limitations and perhaps start looking for additional collaborations or funding opportunities.

It is clear from the membership survey that there are many things that ACUBE has been doing well and many things that our members find highly rewarding. It is also equally clear that there are many things that we can be doing differently, some easy to accomplish, some more difficult. The organizers of the 2008 meeting and the Steering Committee have already implemented some of the easier suggestions. The more difficult suggestions will necessitate further study and incorporation into a Strategic Plan. After examining results from this survey, the Steering Committee has proposed four goals for the Strategic Plan: (1) Lead the academic agenda in biology education, (2) Modernize the face of ACUBE, (3) Develop a plan to increase membership, and (4) Create an atmosphere where creativity and new ideas are encouraged. Members of the Steering Committee have been assigned to each of these goals and will be developing objectives and tasks to fulfill those objectives over the coming year. Any member, however, is more than welcome to volunteer to participate in development of any of the four main goals (contact conrad.toepfer@brescia.edu if interested).

The President and Steering Committee of ACUBE are committed to looking ahead and planning for the future of the society. ACUBE has provided a great service to its members and has had an impact on biology education in its first 52 years. We should continue that tradition and look to expand our impact in the next half century. Changes have already occurred but stay tuned for even more to come!

References:

Book Review

Biostats Basics. A Student Handbook. With BioStats Basics Online: an interactive tutorial and basic collection of statistical tests including questions, glossary, and data sets


ISBN: 0-7167-3416-8
Estimated U.S. Price: $38.00

Biostats Basics is an easy-to-read introduction to statistics for science majors and non-majors that require a foundational statistics course. Commonly used statistical tests are discussed using simple, yet effective examples to stress the important criteria for employing, and most importantly, differentiating between specific tests. The chapter layout has engaging text, effective graphics, a summary and “Review exercises”. This chapter format, along with traditional statistical tables, a glossary, and the inclusion of a summary guide entitled “Choosing the Right Test”, underscore the authors’ commitment to making statistics understandable to all students. The book’s size and spiral-bound paperback format truly makes this book a convenient and affordable “student handbook”.

Information about “Cause and Effect” and “Data”, required underlying knowledge to understand and apply basic statistics, are covered in the first two chapters. From this point on a mini “Choosing the Right Test” flow chart precedes each remaining chapter’s specific statistical test discussion. For students to grasp the math of the book’s statistical tests, a sound algebra background is adequate. Furthermore the explanations are not “bogged down” with too much theory as the presentation of statistical concepts simulates a face-to-face classroom lecture dialogue that provides the basic mechanics for each specific test. Throughout each discussion are sidebars that remind us of basic definitions for a particular test. Graphical representations of specific tests and/or criteria, as well as corresponding example data sets, are well labeled and thoroughly discussed in the text and the figure legends. The chapter summary “Points to remember” compliments the text material, and together with the “Review exercises” provides effectual learning tools. Answers for the exercises are provided with sufficient explanations to reiterate important “points to remember”. To enhance the learning experience for advanced students, a “More Than the Basics” section is included at the end of most statistical test chapters. Finally, Chapter 14, entitled “Once Over Lightly”, is a succinctly written overview of the entire book with highlighted boldprint terminology for easy reference.

As expected, parametric and nonparametric data discussion and examples comprise a majority of the book. However, the authors’ wit shines with their “None of the Above” chapter which made me smile with their clever subtitles “The Quick and Dirty Approach”, “The Academic Approach”, and “The Hard Way: Monte Carlo Simulations”. All of these discussions provide statistical solutions to data sets that many of us have encountered, i.e., “unusual data and special cases”.

Additionally, the each chapter has separate textboxes which identify corresponding interactive statistical applications that can be accessed via an online component through the publisher’s website (http://www.whfreeman.com/gould/). Unfortunately for the majority of students now, this feature is probably not available due to the Biostats Basics Online software requirements for operating systems (“Macintosh OSX, 9, nor Windows XP, ME, 2000 systems are not supported”). Despite this online aspect, the book would work well in any course where students are required to apply introductory or more advanced statistical tests.

Elaine O. Hardwick
Department of Biology
University of Wisconsin-River Falls

Editorial

In the December 2007 issue of Bioscience, Tom Davis, secretary of ACUBE, wrote an editorial calling for national standards for a college biology majors (The Time is NOW for National Standards for a Biology Major, Bioscience vol. 33(4): 42-43). The National Association of Biology Teachers (NABT) have displayed their standards on their website (http://nabt.org/sites/S1/index.php?p=614). Our membership would be well-advised to study these. In addition, membership should review standards
established by the Association for Midwest College Biology Teachers (AMCBT), the predecessor of ACUBE. These were published in *Bioscene* in December 2001 (*AMCBT Guidelines for Evaluating Undergraduate Education in Biology, Bioscene* vol. 17(3): 16-17). They are as follows:

- 480 hours of classroom work in biology (33 semester hours)
- 360 hours of laboratory/field work in biology (approximately one three hour session per week of the semester per course)
- A core curriculum that covers evolution, prokaryotic biology, eukaryotic biology, systematic biology, cell and molecular biology, ecological and environmental biology, genetics, physiological biology, structural (anatomical) biology, and experimental design/biometrics
- Capstone experience such as a senior seminar
- One year of advanced work in biology or in allied fields that is outside of the core
- An undergraduate research experience
- One year of mathematics/computer science
- One year of physics
- Two years of chemistry to include biochemistry

An AMCBT approved program would also include the additional evaluation of:

- Faculty size (minimum of four biologists, three fourths of them with Ph.D.'s in biology)
- Teaching loads (maximum 12 contact hours per week, including labs)
- Examinations, syllabi, and student research reports
- Faculty compensation
- Faculty professional activities
- Library collection (20 subscriptions to refereed journals, access to Biological Abstracts)
- Facilities and equipment
- Budget and administrative structures, support personnel
- Textbooks and use of primary literature
- Placement of graduates

I believe that ACUBE can take a leadership role in this process. I think these guidelines should be discussed among our membership (perhaps in letters to the editor). Feel free to comment by emailing me (stephen.daggett@avila.edu) or contacting me at the address given in our editorial information.

Stephen S. Daggett, Ph.D.
Avila University

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NEW FROM NATURE PUBLISHING GROUP

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