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Stephen S. Daggett
Avila University

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Bioscene is normally published in March, May, August and December. Please submit manuscripts by July 1, 2006 for consideration in the next issue.

Cover image: A weathered chain coral reveals the presence of ancient seas in uplifted rock now at 11,000 feet along the continental divide. Image provided by Ethel Stanley

Articles:

News & Views:

Bioscene: Journal of College Biology Teaching

I. Call for Submissions to *Bioscene*

Bioscene: Journal of College Biology Teaching is a refereed quarterly publication of the Association of College and University Biology Educators (ACUBE). Suggestions for manuscripts include: announcements, web site and book reviews, labs/field studies that work, course development, technological advice, software reviews, curricular innovation, history of biology, letters to the editor, undergraduate research opportunities, professional school, funding sources, current issues, etc.

II. Submission Requirements

Manuscripts may be sent to the current editor, Stephen S. Daggett. Submissions can vary in length, but articles should be between 1500 and 4000 words in length. All submissions should be double-spaced, including figure and table legends, any footnotes, and references. All submissions should come with a cover letter. If the submission is sent attached to an email, please address the subject line as BIOSCENE. The cover letter should contain the complete mailing address (including the street), email address, telephone number, and fax number of the corresponding author.

The manuscript itself should contain the following:

- Manuscript in RTF (Rich Text File) to facilitate distribution of the manuscript to reviewers and to make revisions.
- Tables, graphs, and images should be submitted as individual electronic files. If it is not possible to provide an image in an electronic format such as TIFF for Macintosh or BMP for Windows, please include a clean, sharp paper copy for our use.
- Double space all text including references and figure legends
- Title
- Author(s)
- Name of authors' institution with the address
- Email address
- A brief abstract (200 words or less), followed by keywords
- Number all pages

III. Editorial Review and Acceptance

The manuscript will be sent to two reviewers as coordinated through the Editorial Board. Reviews will examine the submission for:

- **Suitability**: The manuscript relates to teaching biology at the college and university level.
- **Coherence**: The manuscript is well-written with a minimum of typographical errors, spelling and grammatical errors, with the information presented in an organized and thoughtful manner.
- **Novelty**: The manuscript presents new information of interest for college and university biology educators or examines well-known aspects of biology and biology education, such as model organisms or experimental protocols, in a new way.

Once the article has been reviewed, the corresponding author will receive suggestions and comments from the reviewers. Acknowledgement of reviewers' comments and suggestions must be made for resubmission and acceptance. Upon acceptance, the article will appear in *Bioscene* and will be posted on the ACUBE website.

IV. Editorial Policy and Copyright

It is the policy of *Bioscene* that authors retain copyright of their published material.

Deadlines for Submissions

April 1, 2006 May, 2006 Issue **July 1, 2006 Aug, 2006 Issue**

Why the Y Chromosome? – A Look at Male Lineage and Ancestry

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Abstract: Up until a short time ago the Y chromosome played the role of the juvenile delinquent within human chromosomes. It was considered to be rich in junk, short on genes, and rapidly degenerating. Now the Y chromosome is growing up by providing a means for investigating human migration. Through the use of genetic markers on the Y chromosomes, students from a college bioinformatics course were able to determine the migration routes over tens of thousands of years from the 100+ male DNA samples they collected.

Keywords: Y Chromosome, Genetic Markers, Lineage, Migration

Introduction

The year was 1990. It was the time when geneticists published findings on the part of the Y chromosome that conferred maleness, the SRY (Sex Reversal on Y chromosome) gene. Once again the Y chromosome is in the journals. Now, it has been elevated from genomic junkyard to evolutionary revelation [Lewis, 2003].

This tiny chromosome is quickly becoming mighty in how it reveals evidence of ancient demographics histories. In the palindromes (regions of DNA in which the sequence of nucleotides are identical with an inverted sequence in the complementary strand) found within the DNA of the Y chromosome are the clues to the past. To determine the migration route of ancient man a time line was needed; DNA provided the clock. The longer the DNA lineage has been in existence, the more mistakes/mutations the DNA sequence is likely to contain. These mutations on the Y chromosome provide genetic markers (Table 1). By tracking these genetic markers a timeline for man's migration routes can be determined (Figure 1). This approach provides a unique *double helix*: the combining of history and genetics.

Initially, the focus in determining time lines was on mitochondrial DNA that is inherited maternally. It descends from generation to generation from mother to daughter. Mitochondrial DNA evidence shows that females were more mobile than males [Seilstad et al., 1994; Underhill et al., 1996; Ruis-Linares et al., 1996]. This suggested that in most African tribes it was the women who did the traveling probably to find mates [Shnayerson,2005; Cavalli-Sforza, 1997]. The men on the other hand stayed put, so the story that the mitochondrial DNA told only provided half of the answer. The Y chromosome was needed to provide further insight into the "Out of Africa" theory and man's migration. Recently, genetic markers on the non-recombinant region of the Y chromosome have been used as the male complement to mitochondrial DNA. These markers allow for the reconstruction and tracing of ancient human migration routes (Figure 1).

The Y chromosome has become such a research interest that the National Geographic Society is undertaking its most ambitious project, the Genographic project. Under the direction of population geneticist, Dr. Spencer Wells, and at a cost of 40 million dollars over five years, the Genographic project is establishing eleven DNA-sampling centers with the goal of collecting over 100,000 DNA samples worldwide [Shnayerson,2005].

Marker	Years ago	Base pair (bp) size
M168	50,000 years	473 bp
M130	50,000 years	205 bp
M96	40,000 years	440bp
M9	40,000 years	340 bp
M45	35,000 years	352 bp
M173	30,000 years	220 bp
M242	20,000 years	365 bp
M3	10,000 years	241 bp
M2	10,000 years	209 bp
M122	10,000 years	393 bp
M19	<10,000 years	333 bp

Table 1. Genetic Markers for specific time periods and their expected PCR product size

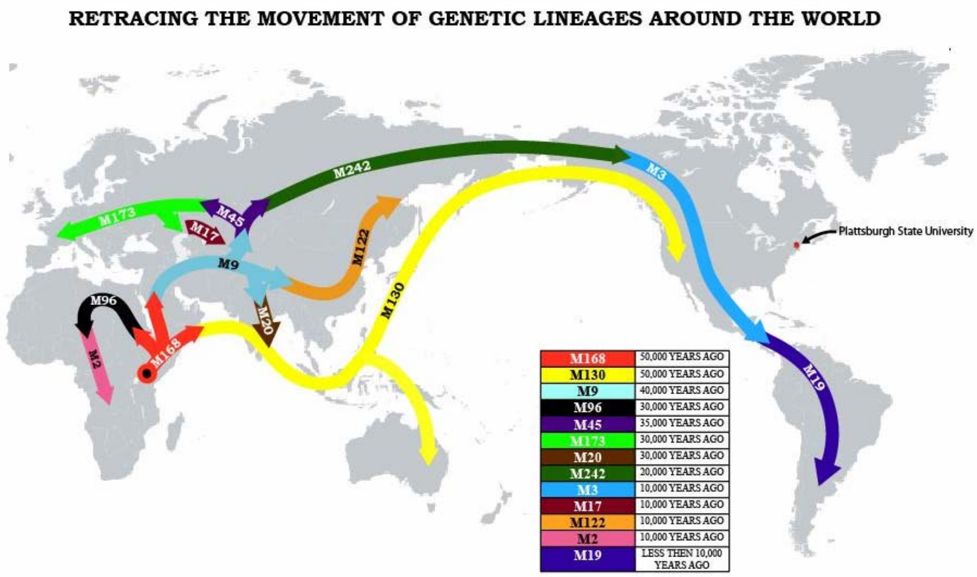

Figure 1. Proposed migration routes of man using genetic markers as suggested by Kunzig (2004). Map created by Kyle Martin, a student in the bioinformatics course.

The main objective for our project was to provide students an opportunity to take part in a complete research experience. By complete, we mean experimental design, laboratory techniques, data collection, and data analysis. The data published here is the result of a research project undertaken by students as part of their junior/senior level college bioinformatics course. The six students working on this project collected DNA samples from over 100 male college students. Through the use of genetic markers, which can date the Y chromosome back 10,000 years, 20,000 years, 30,000 years, 40,000 years, and 50,000 years, the students were able to determine the male lineages, migration routes and the ancestry of the Y chromosome from the tested DNA samples. Their results along with the protocols used are presented in this paper.

Methods

I. DNA isolation by Saline Mouthwash

Prepare a 0.9% saline solution (0.9 g NaCl per 100 mL distilled water); aliquot 10 mL 0.9% saline solution into 50 mL polypropylene tubes. One tube will be needed for each sample collected. Make sure to include at least one female sample to provide a negative control. Also make a 10% Chelex® solution (Chelix 100 Resin from Bio-Rad), 100 µl of 10% chelex will be needed per sample; 10 mL is enough for 100 samples. Chelex does not dissolve in solution, so it will need to be shaken prior to each use. Also it is suggested that a truncated tip be used when pipetting the Chelex solution to freely allow the uptake of the beads within the solution.

1. Have each participant pour 10 mL of the saline solution (0.9% NaCl) into his or her mouth and vigorously swish for 30 seconds.

2. Expel saline solution back into the polypropylene tube. Number the tube.

3. Store samples on ice or in refrigerator until the steps below can be done.

4. Swirl to mix cells in the tube and transfer 1 mL (1000 µl) of the liquid to a 1.5 mL tube, number the tube.

5. Place the sample tubes in a balanced configuration in a microcentrifuge, and spin for 1 minute.

6. Carefully pour off supernatant into paper cup or sink. Be careful not to disturb the cell pellet at the bottom of the test tube. A small amount of saline will remain in the tube.

7. Resuspend cells in remaining saline (~30 µl) by pipetting in and out. (If needed, saline solution may be added to facilitate resuspension.)

8. Withdraw 30 µl of cell suspension, placing it into a new screw cap 1.5 mL tube (make sure to number the tubes) then add 100 µl of 10% Chelex (Shake this solution prior to use). Shake the tube well to mix.

9. Boil cell sample for 10 minutes. Use boiling water bath, heat block, or program thermal cycler for 10 minutes at 99°C. Then, cool tube briefly on ice (optional).

10. After boiling, shake tube. Place in a balanced configuration in a microcentrifuge, and spin for 1 minute.

11. Transfer 30 µl of supernatant (containing the DNA) to a clean 1.5 mL tube. Avoid cell debris and Chelex beads. This DNA sample will be used for setting up the testing of the DNA samples with the genetic markers. Make sure to mark the tubes with the correct sample numbers.

12. Store your sample on ice or in the refrigerator.

II. DNA Amplification Procedure using Polymerase Chain Reaction

1. Using a micropipet with fresh tips add 17.5 µl dH_2O, 2.5 µl of the 20 µM forward primer and 2.5 µl of the 20 µM reverse primer to a PCR tube containing a Ready-To-Go PCR Bead (Amersham). Tap tube with finger to dissolve bead. Table 2 contains all the respective primer sequences for the genetic markers.

2. Use fresh tip to add 2.5 µl of human DNA (from Part I) to reaction tube, and tap to mix. Pool reagents by pulsing in a microcentrifuge or by sharply tapping tube bottom on lab bench.

3. Label the cap of the tube with the sample number.

4. Add one drop of mineral oil on top of reactants in the PCR tube. Note: Thermal cyclers with heated lids do not require use of mineral oil.

5. Store all samples on ice until ready to amplify according to the following: Program thermal cycler for 35 cycles according to the following cycle profile. Each program may be linked to 4°C to hold samples after completion of amplification. However, amplified DNA also holds well at room temperature.
   Denaturing time and temperature 30 sec - 94°C
   Annealing time and temperature 30 sec - 54°C
   Extending time and temperature 45 sec - 72°C

6. Following amplification, load each sample into a 1% agarose gel along with a 100 bp marker. If using ethidium bromide, 10 µl of 10mg/mL ethidium bromide can be added to the agarose mixture (50mL) prior to pouring the gel.

7. The gels can be run for 30-40 min at 120 volts.

8. Visualize each gel using UV light (for ethidium bromide gels). If ethidium bromide was not used, stained the gel in methylene blue (or a similar DNA stain) for 30 min after that destain in water for 10 minutes then view with a white light. Record the results whether or not they revealed the presence the genetic marker of interest.

Safety Issues

As expected in any laboratory where chemical reagents are used, students were required to wear gloves, goggles, and cautioned not to wear contact lenses during the laboratory experience. All reagents were labeled with appropriate hazard warnings to include health hazard, fire hazard, reactivity and any specific hazard. Used buffer from electrophoresis events was placed in a specified waste container under the chemical hood. Gels containing ethidium bromide residues were placed in a biohazard bag, located under a chemical hood. III.

Systematic Approach for Sample Analysis

Feeling somewhat like 'ancestry detectives', the research team chose a plan of attack to begin answering the questions: *Where did we come from?* and *How did we get here?* The students reviewed the literature to determine how the Y chromosome can be used as an evolutionary marker and what genetic markers they should use for their project (Jobling & Tyler-Smith, 2003; Underhill et. al., 1996; Underhill et al., 1997; Underhill et al., 2001; Yuehai et al., 2001; Seielstad et al., 1994; Seielstad et al., 2003; Wells et al., 2001). Once the genetic markers were selected a research plan was designed (Figure 2). Testing was initiated using the 50,000-year genetic marker, M168. Basically each sample was tested using a specific genetic marker, as long as it tested positive for that particular marker (presence of a band on a gel, Figure 3) the experimenter would move on to the next genetic marker. All the samples started with the 50,000-year genetic marker and worked their way towards the 10,000- year markers. Once a sample failed to test positive for a particular marker, it had reached its endpoint in this study. For example, if a sample tested positive for M242 (20,000 years) but not for the M3 marker (10,000 years), then its endpoint would be M242 (20,000 years). There are additional genetic markers for the Y chromosome that could have been used, but it was decided to test the main markers that were suggested in the literature.

Genetic Marker	Primer Sequences	Reference
M168	Forward primer-AGTTTGAGGTAGAATACTGTTTGCT Reverse primer- AATCTCATAGGTCTCTGACTGTTC	Underhill et al., 2001
M130	Forward primer-TATCTCCTCTTCTATTGCAG Reverse primer- CCACAAGGGGGAAAAAACAC	Yuehai et al., 2001
M96	Forward primer- GTTGCCCTCTCACAGAGCAC Reverse primer- AAGGTCACTGGAAGGATTGC	Underhill et al., 2001
M9	Forward primer- GCAGCATATAAAACTTTCAGG Reverse primer- AAAACCTAACTTTGCTCAAGC	Underhill et al., 1997
M45	Forward primer- GCTGGCAAGACACTTCTGAG Reverse primer- AATATGTTCCTGACACCTTCC	Underhill et al., 2001
M173	Forward primer- AATTCAAGGGCATTTAGAACC Reverse primer-TATCTGGCATCCGTTAGAAAAGA	Wells et al., 2001
M242	Forward primer-AACTCTTGATAAACCGTGCTG Reverse primer- TCCAATCTCAATTCATGCCTC	Seielstad et al., 2003
M3	Forward primer- TAATCAGTCTCCTCCCAGCA Reverse primer-AAAATTGTGAATCTGAAATTTAAGG	Underhill et al., 1996
M2	Forward primer- AGGCACTGGTCAGAATGAAG Reverse primer- AATGGAAAATACAGCTCCCC	Seielstad et al., 1994
M122	Forward primer-AAGCAATTGAGATACTAATTCAC Reverse primer-CAACTTCTTTCCCTCAACATAG	Wells et al., 2001
M19	Forward primer- CTGGTCATAACACTGGAAATC Reverse primer- TGAACCTACAAATGTGAAACTC	Underhill et al., 1997
M17	Forward primer-CTGGTCATAACACTGGAAATC Reverse primer-TGAACCTACAAATGTGAAACT	Underhill et al., 1997

Table 2. Genetic Marker Primer Sequences for each of the Genetic Markers

Results

From the time it took to read about Spencer Wells' work in a popular, science magazine [Kunzig, 2004] prior to the start of the semester to the incorporation of it into the curriculum to finally the project conclusion, it has been six months. Results have indicated that college students are quite unaware of their genealogy. In a questionnaire designed to accompany each donated sample of DNA, the donors had very little knowledge of their paternal background beyond their fathers' points of origins. Any future testing done by us will simply include an assigned number for each donor. But for now, at the molecular level, let's focus on the lineages of one hundred young men from around the world and attending a small university in up-state New York, USA

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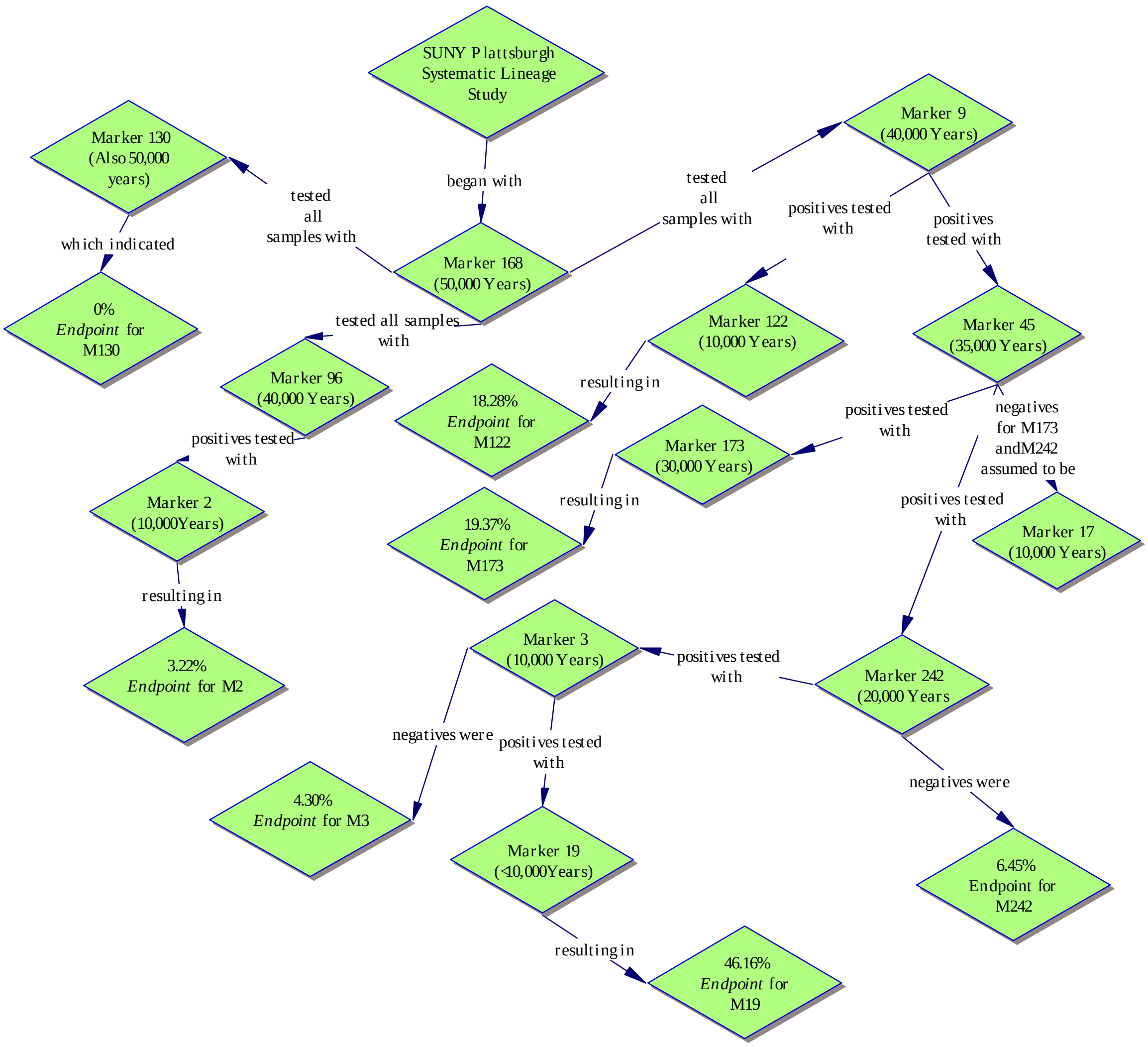

Figure 2. A Concept Map for retracing the movement of genetic lineages for 100+ male students at the State University of New York at Plattsburgh, Plattsburgh, New York. Generated by Sandra Latourelle.

As seen in Table 3 and Figure 2, the results indicated all markers tested were present with the exception of M130. When looking at endpoint genetic markers, the largest number for all samples studied was found when using M19 (Table 3, Figures 2 & 4). 29.02% of all samples tested positive for one of the 10,000-year markers: M17, M3, M2, and M122 (Figures 2, 4, 5). The largest percentage of samples, 46.16%, tested positive for M19 (Table 3, Figures 2 & 4), a marker for less than 10,000 years. It should be noted that all tests were conducted using DNA from female donors as controls.

Marker	Years ago	% in samples
M130	50,000 years	0%
M17	10,000 years	3.22%
M173	30,000 years	19.37%
M242	20,000 years	6.45%
M3	10,000 years	4.30%
M2	10,000 years	3.22%
M122	10,000 years	18.28%
M19	<10,000 years	46.16%

Table 3. Endpoint percentage results from the Genetic Markers used.

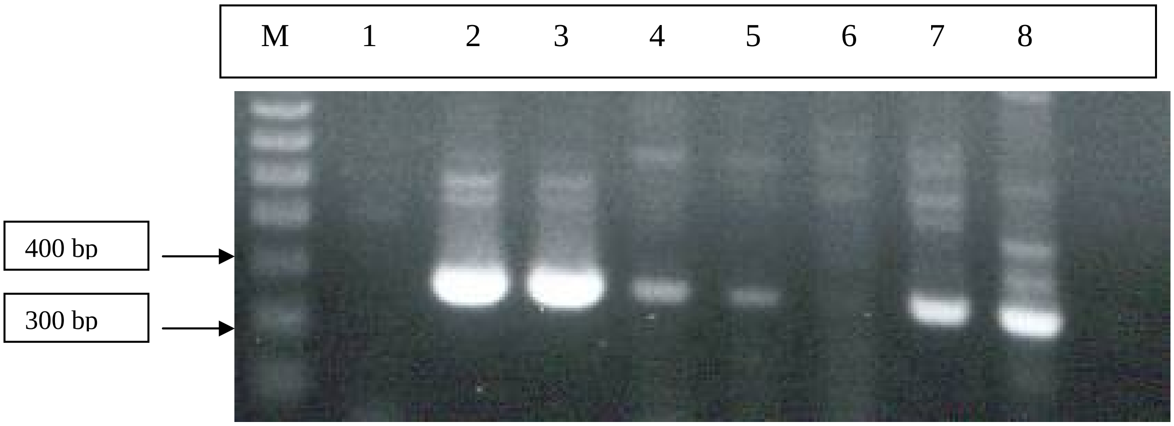

Figure 3. Results from 8 samples amplified with the M45 primers (35,000 years). The expected polymerase chain reaction product is 352 base pairs. Lane M is the 100 base pair (bp) standard. The samples in lanes 1 and 6 did not test positive for the M45 genetic marker. The sample in lane 1 was our negative control (female DNA).

Discussion

What our research students found were glimpses into the past revealed by the mirror like palindromes, markers of mystery — The DNA from our male donors had preserved their paternal legacy permitting inference of human evolution and demographic history [Underhill et al, 2000]. Our four-month study during the course actually allowed us to do a 'long range paternity test'. It was surprising for the students at first to see that 46.16% of their samples tested positive for the M19 marker (Figure 4). This was a marker that would have made its way through Asia, across through Alaska and then into the Americas. The students were expecting a higher percentage of their results to make their migration westward through Europe. This is the beauty of science; the data is the data no matter what the expectations. Reflecting back the students realized that a large number of their sample pool were both minority and international students.

If this research project were to be expanded and not just one part of a bioinformatics course, additional Y chromosome genetic markers would be added. This would hopefully address the 19.37% of our samples that ended their migration at 30,000 years (M173). Presently, there are 100+ genetic markers for the Y chromosome that could be used. We just used the ones that we hoped would give us a basic picture of our 100 students migration.

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Assessment

As mentioned this project was only part of the requirements for a junior/senior level bioinformatics course. For this part the students were assessed on their laboratory notebooks, review and presentation of the literature, laboratory techniques and poster presentation of their results at an on-campus research symposium.

Concluding Remarks

Young men willing to donate some cheek cells for a scientific endeavor provided our original samples. We have no way of knowing whom they are and if they ever heard about the French philosopher, Simone Weil. In his words, "To be rooted is perhaps the most important and least recognized need of the human soul [Smolenyak, 2004]." Perhaps some of these young men will become involved in what Megan Smolenyak refers to in her book, *Trace Your Roots with DNA*, genetealogy- a marriage of genealogy and genetics [Smolenyak 2004].

Acknowledgements

We thank all of the DNA donors for making this project possible. This project was supported by a generous grant from Delta Kappa Gamma Society International, a professional honorary society of women educators

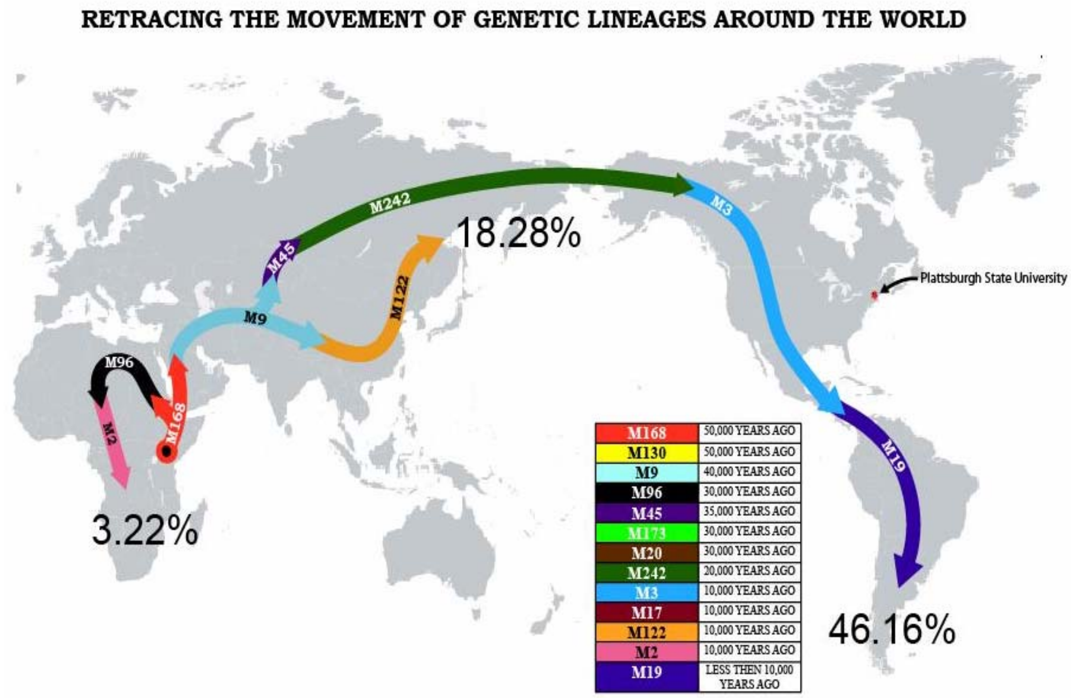

Figure 4. Results for three of the proposed migration routes from our collected samples. The percentages represent the percentage of samples that reached an endpoint for that particular migration marker.

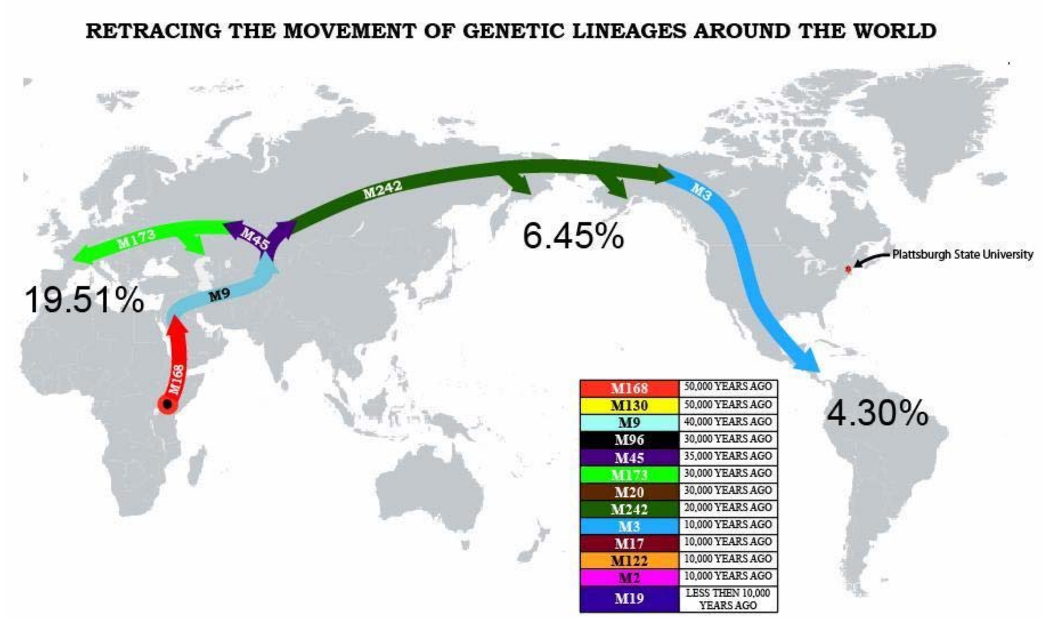

Figure 5. Results for three of the proposed migration routes from our collected samples. The percentages represent the percentage of samples that reached an endpoint for that particular migration marker.

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Call for Resolutions

The Steering Committee of ACUBE requests that the membership submit resolutions for consideration at the 2006 Annual meeting to the Chair of the Resolutions Committee. Submit proposed resolutions to:

Brenda Moore, Truman State University, Division of Science, MG3062, Kirksville, MO 63501,
Email: bmoore@truman.edu
Phone: 660-785-7340

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We are looking for persons who are willing to review manuscripts for *Bioscene*. We need reviewers for a wide variety of subject areas. Reviewers should be willing to provide in depth reviews and detailed suggestions for authors concerning revisions necessary to improve their manuscript for possible publication. Reviewers should be willing to provide a rapid turn-around time for the manuscripts they review. If you are interested in reviewing for Bioscene, please send an email that includes your phone number, FAX number, and a list of the areas for which you are willing to review to: Stephen S. Daggett, *Bioscene* editor, at stephen.daggett@avila.edu.

Call for Applications -- John Carlock Award

This Award was established to encourage biologists in the early stages of their professional careers to become involved with and excited by the profession of biology teaching. To this end, the Award provides partial support
for graduate students in the field of Biology to attend the Fall Meeting of ACUBE.

Guidelines: The applicant must be actively pursuing graduate work in Biology. He/she must have the support of an active member of ACUBE. The Award will help defray the cost of attending the Fall meeting of ACUBE. The recipient of the Award will receive a certificate or plaque that will be presented at the annual banquet; and the Executive Secretary will provide the recipient with letters that might be useful in furthering her/his career in teaching. The recipient is expected to submit a brief report on how he/she benefited by attendance at the meeting. This report will be published in *Bioscene*.

Application: Applications, in the form of a letter, can be submitted anytime during the year. The application letter should include a statement indicating how attendance at the ACUBE meeting will further her/his professional growth and be accompanied by a letter of recommendation from a member of ACUBE. Send application information to: Dr. William J. Brett, Department of Life Sciences, Indiana State University, Terre Haute, IN 47809; Phone: 812-237- 2392; FAX: 812-237-4480; Email: lsbrett@scifac.indstate.edu.

If you wish to contribute to the John Carlock award fund, please send check to: Dr. Tom Davis, ACUBE Excecutive Secretary, Department of Biology, Loras College, 1450 Alta Vista, Dubuque, IA 52004-0178

Using a “Primer Unit” in an Introductory Biology Course: “A Soft Landing”

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Abstract: This study aimed to facilitate students’ entrance to an introductory cell biology course for biology majors. The most prominent difficulty in this introductory course, is students’ poor background-knowledge, such as a lack of understanding of very basic concepts and terms, and the huge differences in students’ background knowledge. In order to bring all the students to a common and adequate level of comprehension and familiarity of basic terms, thus giving a fair chance to all attending the introductory cell biology course, the chief instructor decided to build a “primer unit”. The unit provided an overview of the subject matter of the course, and it was placed on the course website before the beginning of the course. The findings show that students who consulted the primer unit came to the course better prepared. The primer helped to reduce the gap between students who studied advanced biology in high school and those who did not. Even though the differences between students who went over the primer and those who did not was not sustained after formal learning, students reported that due to the primer they started the course less intimidated and with a better idea about what to expect.

Keywords: Higher education, introductory course, cell biology, primer unit

Introduction

This paper is part of a longitudinal study which aimed to improve the instruction in introductory biology courses. Our choice to focus on the introductory cell biology course was due to two main reasons. One was students’ statements, such as: “This course [introductory cell biology] sometimes feels like a shower of new concepts threatening to drown me out.” The other was the course instructor’s view that a major cause for students’ difficulties in the course was a lack of background knowledge in science and in biology in particular.

Our university offers some programs that are designed to help students enrich their background knowledge prior to undergraduate biology studies. For example, it is highly recommended for candidates who have not completed high-level mathematics and chemistry to attend preparatory courses. However, no such preparatory courses exist for biology related topics, despite the fact that the students’ backgrounds differ greatly, especially due to the fact that about 40% of the freshmen have not studied advanced biology in high school (Marbach-Ad, 2004).

We believe that the students’ experience in the first year of their studies is a very important element in their decision to stay in or leave their field of study. Tobias (1990) claimed that introductory science courses are responsible for driving away many students who began majoring in science programs. In the mid- to late 1980s, concerns about the number of freshmen entering and remaining in math and science-based majors surfaced. Not only was there a striking decline in entering-freshmen interested in science and in math (Green, 1989), but the number of students who subsequently moved out of science, math, and engineering majors by their senior year was substantial and ranged from 20% in math and physical sciences to 40% and 50% in the life sciences and engineering (Astin, 1993; Astin & Astin, 1993). Moreover, the losses were from a pool of highly capable students (Green, 1989; White, 1992).

One of the major reasons that Seymour (1995) indicates for drop-out relate to the course curriculum, especially the amount of material that students have to learn in a short time. Such complaints were mainly raised regarding the introductory courses. Belzer, et al. (2003), discussing students’ difficulties in introductory courses, refer to the poor background knowledge and lack of learning and reasoning skills that students bring to college along with their insufficient preparation for classes.

Views regarding the importance of prior knowledge have been present for several years in the science education literature, largely in terms of Ausubel's (Ausubel, et al., 1978) assimilation theory of meaningful reception learning. These authors implied that meaningful learning depends on the ability of the teacher to instruct the subject matter at hand in a well-organized way that connects the new knowledge with the learner's cognitive structure (Ausubel, 1968). Novak (1977, 1990) believed that learners acquire a hierarchically organized framework of specific concepts, each of which permits them to make sense out of new experiences. If these prior concepts are lacking, no new concepts can be acquired.

The introductory cell biology course is one of the corner stones for life sciences majors in their first year of their undergraduate studies. This course exposes students to many new concepts and ideas in molecular biology. In order to reduce the gap between students' background knowledge and give a fair chance to all the students in the introductory cell biology course, the chief instructor decided to build a "primer unit" and placed it on the course website before the beginning of the Spring 2003 course. The primer was available to students starting at the end of the Fall 2002 semester. Thus students could review the primer during the vacation between semesters. The primer was a Power-Point presentation which contained text and pictures, mostly taken from the course textbooks. It provided an overview of the subject matter that was presented in the first six lectures of the course, which emphasized major concepts and ideas. Students, who did not study biology in high school or those who did but felt weak in this subject, could go over the material before the beginning of the semester.

During the present study, students answered three questionnaires. The first questionnaire was handed out before exposure to the primer unit and examined students' background knowledge in the subject. The second questionnaire was intended to yield a profile of the students who chose to use the primer and to examine the impact of the primer on students' achievement at the beginning of the semester. The third questionnaire was handed out to the students after the first six class sessions and examined the impact of the primer after the subject-matter was taught in class. We focused our study on the following three research questions:

1. What was the profile of students who used the primer unit?
2. What was the impact of using a primer unit on students' preparedness for the course and on students' conceptual understanding after the material was taught in class?
3. What was the students' attitude towards the use of the primer unit?

Method

Cose

Course Description

The introductory cell biology course for freshmen is a four-credit, one-semester class (28 lectures - two hours, twice a week). Three instructors from the department of cell research and immunology teach the course in rotation, each of them specializing in specific topics. The instructors cooperate and build the curriculum as a successive unit. The course rationale is to teach the central cellular processes from both a functional and a structural viewpoint, emphasizing basic cellular *mechanisms*, while paying relatively less attention to cell *morphology*. The first six lectures serve as an introduction chapter to the course and provide a systemic overview of the macromolecules (carbohydrates, phospholipids, nucleic acids, and proteins) that build the cell and are involved in the life cycle processes. The instructor emphasizes similarities in macromolecular structures by presenting each one of them as a complex compound or polymer chain consisting of monomer building blocks.

This study was conducted in the Spring of 2003. Four hundred and fifty students, majoring in biology, were enrolled in this class. Prior to the course, in the one-month vacation between the Fall and the Spring semesters, the chief instructor of the course placed the primer unit on the course web site. The instructor encouraged students to review the primer unit at their own time and pace. The primer included 32 Power-Point color slides and represented the main issues of the first six lectures of the course. The main primer topics were the macromolecules of the cell (sugars, proteins, lipids and nucleic acids), their compounds, and their functions in the cell.

Research Instruments and Sample

Written questionnaires were handed out to the students during the following occasions:

1. The first questionnaire was handed out in the last week of the Fall 2002 semester (see Appendix A). This questionnaire examined the student's background knowledge in cell biology prior to the cell biology course. One hundred and sixty eight students completed the questionnaire. From this questionnaire, we collected student characteristics, such as: gender, age, advanced courses taken in high school, and psychometric scores. In addition, students

were asked to answer seven open-ended questions including "What are the main functions of nucleotides?", "What is a monomer?" and "What is a polymer?" There were also five multiple-choice questions (e.g., "Phospholipids are made of: a. sugar units; b. lipids; c. proteins") and one fill-in the blank question.

2. The second questionnaire was distributed during the first week of the course. This time, 261 students responded. The questionnaire included content questions similar to those in the first questionnaire, as well as questions about the primer (e.g., "Was the primer clear?" "Do you think it would be a good idea to use this type of a primer in other courses?")

3. The third questionnaire was administered in the sixth class session (the third week of the course). This questionnaire included the same content questions as the second questionnaire, as well as two questions about the primer. One hundred and seven students completed and returned the third questionnaire.

Data Analysis

To evaluate students' responses, we referred to the scientific literature (Nelson & Cox, 2000; Suzuki, et al., 1999). An example of a response that was considered a complete answer to the question, "What do nucleotides consists of?" was "A nucleotide consists of a nitrogenous base, a five-carbon sugar, and one or more phosphate group(s)." We ranked each response (An example for the open-ended questions' evaluation coding, see Appendix B) and then created a score (between 0 and 100) for each student.

In order to validate the grading scheme, each of the authors (two science educators and the instructor) built his/her own grading scheme. In addition, a sample from the students' questionnaires was given to a researcher in science education, who was not connected to this study, and to a high school biology teacher. Each independently graded the questionnaires they received according to the approved grading scheme, and their grades were found to be similar to those given by the authors. For each questionnaire, we calculated a total score, and this enabled us to examine correlations between students' scores on each occasion and compare differences in achievement among subgroups (i.e., students who used the primer and students who did not, or students who studied high school advanced biology and those who did not). The attitude questions about the primer were analyzed qualitatively by building categories of similar responses. In order to analyze the questionnaires and compare among subgroups, we used an independent *t*-test. To examine the similarity of demographic characteristics between these groups we used chi-square tests.

Results

About 45% of the students who completed the questionnaires (147 out of 317) indicated that they consulted the primer. Table 1 shows that the demographic distribution in the group of students who used the primer (female – 69%; advanced biology – 60% and the average score on a psychometric exam - 676.3) was similar to the demographic distribution of the students that answered to the questionnaires (female-67%; students who took advanced biology at high school-55%, psychometric exam mean scores-679.3). Chi square analysis showed that there were no significant differences between these groups.

Students' profile	Students who consulted the primer N=147	Students who answered the questionnaire N=317
Age		
18-20	10%	11%
21-25	84%	81%
26-32	6%	8%
Gender		
female	69%	67%
male	31%	33%
Advanced biology in high school	60%	55%
Advanced chemistry in high school	54%	48%
Advanced physics in high school	28%	23%
Advanced math in high school	94.6%	92%
Average psychometric test scores	676.3	679.3

Table 1. Profile of students who consulted the primer in comparison with their proportion in class

Students' explanations for not using the primer were mainly procedural, including "I did not see the note about the primer on the web site", "The Power Point file was too heavy to print at home." Other explanations were mainly of the type: "The vacation between semesters is already overloaded with tests and assignments; therefore, I didn't have time to look at the primer." "I don't think that it's important to go over the primer, since we will go over these topics in the beginning of the course."

Questionnaire	Did not use the primer	Used the primer	Sig.
First (N=168)	**17.4**±0.17	**18.8**±0.16	NS
Second (N=261)	**26.6**±0.23	**35.7**±0.23	$p < .001$
Third (N=107)	**69.0**±0.17	**75.2**±0.24	NS

Table 2. Students' mean scores* in the content questionnaires (*means score are calculated out of 100)

Table 2 summarizes the findings concerning students' mean scores on the content questions in the three questionnaires. The first questionnaire reflects the background knowledge of the students in cell biology prior to the course. The mean scores in this questionnaire, both of students who ultimately used the primer (primer 18.8) and of those who did not (no primer 17.4), were very low and with no significant difference, which suggests that these two groups were comparable in background knowledge.

In the second questionnaire, both groups gained higher scores. This could be a result of having to complete the general test twice or the fact that they had studied for the other exams, of the first semester (e.g., introductory course in evolution) where some of the subject matter may have been relevant. However, the fact remains that the mean score of the group that used the primer (35.7) was significantly higher than the mean score of the group that did not use the primer (26.6). These results suggest that the primer helped the students who used it to embark on the course with better background knowledge than students who did not use it. In the third questionnaire, handed out after six class sessions, students from both groups achieved markedly better scores, yet those using the primer did better than those who did not (75.2 as compared to 69.0); this difference was not statistically significant.

Questionnaire	Did not study advanced biology	Studied advanced biology	Sig.
First (N=168)	**15.3**±0.17	**19.5**±0.15	$p < .05$
Second (N=261)	**30.7**±0.21	**35.5**±0.23	NS
Third (N=107)	**70.6**±0.15	**74.7**±0.18	NS

Table 3 Students' mean scores* in the content questionnaires: comparison between students who study advanced biology in high school and those who did not (*mean scores are calculated out of 100)

Interesting results emerged when we compared the achievements of students who studied advanced biology in high-school and students who did not (Table 3). In the first questionnaire, as was expected, students who studied advanced biology scored better (19.5) than students who did not (15.3); however, in the second questionnaire these differences disappeared. This might suggest that students who did not study advanced biology in high school might have enriched their background knowledge by using the primer.

Although differences in scores were sometimes marginal, the students' attitude toward the primer was very positive, which was indicated by the fact that more than 85% of those who used the primer thought it would be useful in other courses. Some of the statements were: "The primer helped me to prepare for the course, it reduced my anxieties about the course;" "When I came to the first class I was less intimidated since I new what to expect from the course;" and "I don't have a strong background in biology, and the primer helped me to catch up with other students before the hectic period of the semester." Some of the criticism about the primer was the issue that it was in English (while the vast majority of the students' mother-tongue was Hebrew). It is noteworthy that the instructor of the course intentionally used English as the language of the primer, since this is the language of the main text. The primer was intended to introduce the students to the need to cope with English as well as to deal with the specific subject matter.

Discussion and Conclusions

This study describes an attempt to reduce the burden of new concepts at the beginning of an introductory course, without compromising the high standards and wide curriculum coverage of the course. For this, a primer unit was provided to the students prior the beginning of the course.

The findings show that students who used the primer came to the course better prepared. In addition, it seems that the primer helped to reduce the gap between students who studied advanced biology in high school and those who did not. Interestingly, the differences between students who used the primer and those who did not were not sustained after the formal learning of the subject. These results are similar to the findings of Papp, et al. (1987), who reported that in a cell biology course, in the Virginia School of Medicine, prior knowledge did not predict the final exam scores. They explained that since many factors influence the students in the course of their studies, background knowledge becomes less significant towards the end of the course. Nevertheless, we did find that the primer helped students to come to the course better prepared at a relatively low expenditure of effort. Students who referred to the primer reported they came to the course less intimidated and with a better idea about what was expected of them.

Although the primer alone did not measure real academic improvement for long term achievement, we believe that the greatest impact was to provide a psychological advantage for the students. We armed the student with a greater sense of confidence and a feeling that the teachers care and have attempted to ensure a "soft landing".

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Appendix A: The first questionnaire

Name: **I.D.:**

Advanced learning at high school: Biology ___ Chemistry ___ Physics ___ Math ___

Age: ____ Gender: _____

Answer the following questions:

1. Explain what is a monomer and what is a polymer:

____

____

2. Fill in the table:

Polymer	Monomer
DNA	
	Amino acid
RNA	
	Glucose

3. What is a carboxyl group?

4. Which molecule contains carboxyl group?

a. sugar

b. nitrogen base

c. fatty acid

d. I don't know

5. Phospholipids contain:

a. sugars

b. lipids

c. proteins

d. I don't know

6. A peptide bond occurs commonly between:

a. two amino acids

b. two nucleic acids

c. two fatty acids

d. do not know

7. What are the main functions of nucleotides in the cell?

8. What is the meaning of “deoxyribose?” Name a molecule that contains deoxyribose.

9.What are the differences between RNA and DNA, and what are the similarities between them?

10. What is the meaning of the phrase “ATP is an energy coin”?

____

____

____

11. What is the relationship between nucleic acids and amino acids?

____

____

____

12. Nitrogen base G is paired with nitrogen base:

a. A

b. B

c. C

d. T

d. I don't know

13. Glycogen is a polymer of:

a. sugars

b. lipids

c. amino acids

d. I don't know

Thank you for your cooperation!

Appendix B: The coding of the open-ended question 7: “What are the main functions of the nucleotides in the cell?” The answer should refer to the genetic function (building blocks of the DNA) and to the energetic function (The nucleotides’ phosphate groups are common energy currency in all cells).

Categories of answers	**Score**
An answer that includes the genetic and the energetic aspect: Example: *“building block of DNA and maintain available energy to the activity of the cell.”*	3 points
An answer that refer to one function only: Example: *“they are components of the nucleic acids (DNA and RNA) and they carry the genetic information that translated to proteins.”*	2 points
An answer that refers to the structure only: Example: *“they are components of the DNA and the RNA.”*	1 points
* Incorrect answers like: *“Monomers of amino acids.”* * “I don’t know” or “I don’t remember” * No response.	0 points

Student- and Teacher-Centered Learning in a Supplemental Learning Biology Course

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Abstract: Students who chose to enroll in a supplemental course associated with a large biology lecture performed better on lecture exams than those students who chose not to enroll in the supplemental course. Sections of the supplemental course were taught with instructor-centered methods prior to some exams, student-centered methods prior to other exams, and a mixture of student- and instructor-centered methods prior to the first and final exams; the treatment (instructor- or student-centered learning) sequence varied between sections. This reciprocal repeated-measures design allowed for comparison of students' performance on exams following a series of instructor-centered, student-centered, and mixed sessions. The relative benefits of student- and instructor-centered instructional methods, or a mixture of the two methods, varied among supplemental sections. The section with the highest overall score showed the most improvement following mixed instructional methods, the two intermediate sections showed the most improvement in exam performance following student-centered instruction, and the section with the lowest overall score did not show consistent improvement. Those sections that improved in response to student-centered or mixed instruction methods maintained their improved exam performance throughout the remainder of the semester.

Keywords: introductory biology, student-centered learning, supplemental instruction.

Introduction

Whereas lectures and textbooks may be an efficient method of presenting knowledge, most students need additional activities to process the information presented in lecture. Small group cooperative learning sessions complement lectures by providing a social context in which a student constructs individual understanding of the content presented in lecture. Just as discourse is a central component of scientific process, students working with peers to explore their understanding of scientific content is a central component of learning science (Tien, *et al*. 2002). Many instructors have adopted student-centered teaching methods (Johnson and Malinowski, 2001) to engage students in their learning processes and by doing so increase content acquisition as well as metacognition, student understanding of the way that they learn. Such learning will hopefully provide students with a self-sustaining level of biological literacy.

Large science courses present a particularly challenging environment for the implementation of student-centered learning strategies. This problem is being addressed on many fronts: creative teaching strategies which promote student involvement in the lecture course (Klionsky, 2001), workshops (Udovic *et al.*, 2002) or studio sessions (Roy, 2003) in place of lecture sessions, inquiry-based laboratory exercises (Herrnkind and Bowling,1999; Moss, 1999; Preszler, 2004a; Turner *et al.*, 1988) and smaller interactive sessions, which supplement the larger lecture course (Ogden *et al*., 2003; Van Lanen and Lockie, 1997). In a previous study (Preszler, 2004b), I found that a single cooperative concept mapping session improved students' performance on biology lecture exams more than traditional assignments. In this current study, I evaluate the impacts of 12 weekly small group sessions of a Learning Biology workshop course on students' exam performance in the associated large lecture course. I also assess the effects on lecture exam performance of two approaches to teaching the workshop course: student-centered and teacher-centered sessions.

Supplemental Instruction (SI) is a popular model for associating small group learning sessions with larger lecture courses. It is a program used by over 900 institutions, which aims to help students learn the content of challenging courses, while at the same time improving their more general learning skills (Center for Academic Development, 2003). A central tenet of SI is that sessions are led by peer instructors. I chose initially to teach 4 sessions myself in order to develop a first-hand understanding of SI prior to training and supervising student peer instructors. I also required participants to enroll in a one credit Learning Biology course which was graded on attendance and participation, rather than using voluntary attendance typical of most SI programs. While it is not clear if these sessions should fall within the general category of SI, they were used to assess the effectiveness of small-group sessions and of student-centered learning activities, both of which are central components of this popular program.

Constructivist theory presents learning as a process of knowledge acquisition and assimilation into each individual's existing knowledge domains. This suggests that illuminating relationships between known and recently acquired knowledge is a key step in meaningful learning (Alters and Nelson, 2002). Student-centered teaching methods encourage discussion and consideration of course material relative to students' existing knowledge base and by doing so promote constructivist learning. Alternatively, instructors with a view of both students' initial understanding and a more complete understanding of the ultimate course goals may better illuminate connections using teacher-centered activities. I personally feel the greatest sense of accomplishment when my students take ownership of their learning process during successful student-centered activities. However, I did not want to propose a revision of our introductory biology curriculum without more objective measures of the benefits of supplemental seminars in general, and an assessment of these two contrasting pedagogical approaches: student- versus teacher-centered instructional methods.

In this experiment, I compare the performance on a sequence of lecture exams of students enrolled in only the lecture, in comparison to students enrolled in both the lecture and the Learning Biology seminar. I also applied a reciprocal sequence of student- and teacher-centered activities across the four sections of the Learning Biology seminar to compare the influence of these teaching strategies on student performance on lecture exams through the semester. As a result of focusing on differences in students' sequence of scores across the three groups, and varying the order of the treatments, any variation in the difficulty of exams did not bias our conclusions.

Methods

In an effort to improve students' performance on exams in a freshman biology lecture course, and to improve their more general learning skills, I developed a one credit Learning Biology course. The lecture course covered four major topics (genetics, evolution, diversity, and ecology) with an exam at the end of each topic and a miniexam half way through the first section, worth half as much as a full exam.

Recruitment

After the miniexam, I opened four sections of a one credit Learning Biology course to help students learn to study in the context of their biology course. The Learning Biology course started immediately, but students were given two weeks to enroll; absences during these first two weeks did not count against students' grades. During these two weeks, I repeatedly described the Learning Biology course in lecture, and invited students to enroll in it. Enrollment in the lecture course was 206 students. Each Learning Biology section was limited to no more than 12 students. The Learning Biology section identified in this paper as ST1 quickly recruited 12 students, TS2 then filled at 12 students, TS1 had 9 students, and ST2 initially only had 3 students. I encouraged students signing up at the end of the enrollment period to enter section ST2 which brought the enrollment up to 7.

Treatments

In order to determine the relationship between enrollment in Learning Biology and performance on lecture exams, students were categorized as attending lecture only or attending lecture as well as participating in the Learning Biology course. In order to determine the influence on lecture exam performance of student- in comparison to teacher-centered methods of teaching Learning Biology, I assigned students in Learning Biology to sequential treatments. I taught students in the teacher then student sections (TS1 and TS2) using teacher-centered methods between exams one and two, and student-centered methods between exams two and three. Students in sections ST1 and ST2 were given the reciprocal treatment of student-centered methods prior to exam two, and teacher-centered methods prior to exam three.

Both methods of teaching the Learning Biology course actively involved students in activities including concept mapping, reorganizing their notes, analyzing previous exams, and developing answers to review questions. The difference between the two treatments was that when using a teacher-centered approach, I was standing at the white board leading the lecture/discussion; when using a student-centered approach, I defined the general activity and then students worked in groups of two to four students while I circulated around the classroom keeping them on track with prompts. For example, when making a concept map using the teacher-centered method, students would contribute terms which I would list on a white board. I would then lead a discussion of the relationships among the terms and while doing so illustrate our discussion by making a concept map. Alternatively, when making a concept map using a student-centered approach, students would work within their small groups to generate concepts associated with a major topic and would write the name of each concept on a post-it note. Each group would then construct their own concept map on their group's white board by arranging the post-it notes on the white board and connecting them with arrows labeled to indicate the relationships. I would circulate and ask leading questions, but during these student-centered activities, I avoided telling students how to construct their maps.

Data Analyses

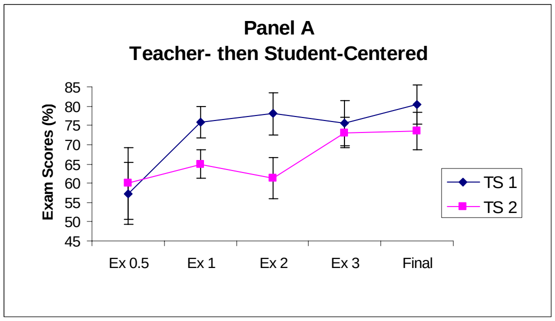
Students enrolled in Learning Biology who did not attend at least 67% of their sessions were excluded from the analyses of the impact of the Learning Biology course, and the two treatments applied to the Learning Biology sections, on exam performance. Students with poor lecture attendance were not removed from the analyses, as attendance was not recorded in the large lecture course. The analysis only included students who had taken all the lecture exams at the assigned times. These limitations on students included in the analyses were applied retroactively across all exams and reduced the number of Learning Biology students included in the analyses from the initial enrollment of 40 to 31 (subsample sizes: 14 students in Student-Teacher sequence, 11 in ST1 and 3 in ST2; 17 students in Teacher-Student sequence, 9 in TS1 and 8 in TS2), and reduced the number of lecture-only students from 166 to 132. The results were analyzed with a repeated-measures analysis (Systat, 2002). Exam scores in the miniexam and the 4 major exams were the dependent variable. Student category, the independent variable, had three levels: students in lecture only, Learning Biology students who were taught with teacher-centered method prior to exam two and student-centered methods prior to exam three (TS sections), and Learning Biology students who were taught with student-centered methods prior to exam two and teacher-centered methods prior to exam three (ST sections). The test statistic of interest was the analysis of the pattern of student test scores across the 5 exams (the repeated measure) associated with student category (the treatment variable).

In order to further understand differences in student performance associated with sections of the Learning Biology course, an analysis of variance was used to compare student attendance between the four sections of Learning Biology. This analysis used all 40 students enrolled in the Learning Biology course.

Results

The pattern of student performance across their five exams varied among the three groups shown in separate panels in Figure 1 (Exam by Treatment Interaction Term, Wilks' Lambda $F_{8,314} = 2.92$, $p = 0.004$). This difference between groups was primarily due to differences between students who were only enrolled in the lecture in comparison to students who enrolled in the Learning Biology course in addition to the lecture. Students who were only enrolled in the lecture showed modest improvement between the initial mini-exam and exam one and then their performance gradually declined through the semester (Fig. 1, Panel C). These students showed no significant variation in performance across the three midterm exams (Wilk's Lambda $F_{2, 130} = 2.62$, $p=0.077$). In contrast, three of the four sections of students in the Learning Biology course were able to sustain the improved exam performance they reached at different times during the course (Fig. 1, Panel A: TS1 prior to exam1, TS2 prior to exam3; Fig. 1 Panel B: ST1 prior to exam2). The results driving the significant exam by treatment interaction are most clearly seen by comparing the initial and final exam scores of the lecture only and the Learning Biology Workshop students. The scores of students who chose to only enroll in the lecture course were higher on the initial miniexam (lecture only 66.22%, workshop students 59.52%); however, students in the Learning Biology Workshop performed better on the final exam (lecture only students 66.88%, workshop students 73.27%).

Students in the two treatment groups applied in the Learning Biology course did not consistently differ in their performance across the five lecture exams (Wilks' Lambda $F_{4,26} = 1.43$, $p = 0.252$). As illustrated within the panels A and B of Figure One, there were dramatic differences between sections of the Learning Biology Workshop that had been given the same treatment. The TS1 section improved most rapidly in response to mixed student- and teacher-centered strategies prior to exam one and the final (Fig. 1, Panel A). The TS2 (Fig. 1, Panel A) and ST1 (Fig. 1, Panel B) sections improved following their student-centered Learning Biology sessions. In contrast, ST2 (Fig. 1, Panel B) began the course prior to the Learning Biology sessions with a much lower average on the initial mini-exam, and responded more positively to teacher- rather than student-centered activities, although they never reached a passing level.



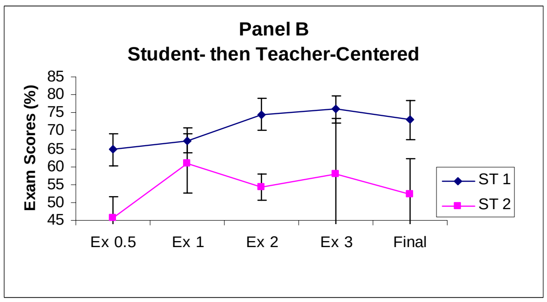


Figure 1. Student exam performance by treatment (panels) and section (lines in panels). Data points illustrate the mean exam scores, bracketed by the standard errors. The students illustrated in Panel A participated in workshops (TS1 & TS2) which were taught with teacher-centered methods prior to exam 2 (Ex 2), student-centered methods prior to exam 3 (Ex 3), and a mixture of teacher- and student-centered methods prior to the initial miniexam (Ex 0.5), exam 1 (Ex 1) and the final exam (Final). Students illustrated in Panel B participated in workshops (ST1 & ST2) which were taught with student-centered methods prior to exam 2, teacher-centered methods prior to exam 3, and mixed methods prior to the miniexam, exam 1, and the final exam. Students illustrated in Panel C were only enrolled in the lecture course and did not enroll in the Learning Biology Workshop.

Student attendance varied significantly among the four sections of the Learning Biology course ($p = 0.006$). The average number of student absences was surprisingly similar among three of the sections (ST1 = 1.50 absences per student, TS1 = 1.44, TS2 = 1.50). However, students in section ST2 missed an average of 4.0 of the weekly meetings during the semester.

Overall, students in the Learning Biology course performed better on lecture exams and were able to maintain increases in performance through the semester more effectively than students who did not participate in the Learning Biology course. The section of Learning Biology with the highest lecture exam performance (TS1 Fig. 1, Panel A) benefited more from a mixed learning approach, rather than strictly student- or teacher-centered activities; the section with the lowest exam performance and lowest attendance (ST2 Fig. 1, Panel B) showed an inconsistent response, possibly benefiting most from teacher-centered instruction, but did not reach a passing level; the two sections with intermediate performance on lecture exams (TS2 & ST1 Fig. 1 Panels A & B) benefited most from student-centered teaching techniques.

Discussion

This study revealed a significant association between participation in a weekly Learning Biology session and improved performance on lecture exams. Enrollment in the Learning Biology course was optional for students enrolled in the general biology lecture. As Ogden *et al.* (2003) note, studies which have revealed positive correlations between voluntary participation in Supplemental Instruction(SI) programs and outcomes such as improved grades (Grise' and Kenney, 2003; Ogden *et al*., 2003; Van Lanen and Lockie, 1997) and improved retention (Ogden *et al*., 2003) are limited in their ability to infer cause and effect due to selection bias. Students participating in SI programs, and students enrolled in my Learning Biology course, may perform better than non-participating students due to the effects of the supplemental courses, due to a difference in motivation (they cared enough to attend voluntary SI sessions or enroll in my LB course), or most likely, due to a combination of these two factors. I felt it would be inappropriate to assign randomly students to the supplemental course, and therefore exclude participation by students who didn't happen to be selected, because the balance of the evidence strongly suggests participation in such courses increases student learning. In this study, students enrolled in the Learning Biology Workshop had a lower average score on the initial miniexam (Lecture only 66.22, Workshop 59.52), but improved much more through the semester and had a higher average score on the final (Lecture only 66.88, Workshop 73.27). Studies, which have partially factored out the effects of differences in initial motivation from effects of SI, have found that the SI students have performed significantly better than students in a motivational control group who wanted to attend supplemental instruction, but had serious schedule conflicts (Arendale, 1997; Ramirez, 1997). A controlled experiment in which students in a developmental mathematics course were assigned to treatments of no supplemental instruction, traditional SI, or SI with participation of the SI leader in lecture activities demonstrated dramatic benefits of both versions of SI on student success rates (Wright *et al*., 2002). In an experiment conducted with the same general biology course described in this article, students were randomly assigned to different sequences of traditional homework assignments in comparison to cooperative concept mapping sessions (Preszler, 2004b). In that study, students performed three percentage points, a third of the way from a minimum score of one grade up to the next grade, better after a single cooperative concept mapping session. In this study, students enrolled in the Learning Biology course which met once a week for 12 weeks improved 13.48 percentage points between the first and last exams, and students who only attended lecture improved 0.66 percentage points.

Contrary to my expectations, there was not a consistent benefit of student-centered in comparison to teacher-centered approaches. There was interesting variation among sections in their responses to the treatments applied to the learning biology course suggesting that the choice of instructional methods should be informed by frequent formative assessments of individual classes and not rigidly tied to the instructor's favorite pedagogy. The section which never reached a passing level (ST2 Fig. 1, Panel B), also had significantly worse attendance, and not coincidently, was the section at a less popular time slot composed of students who enrolled late. We have seen this same pattern in an unpublished study, students who are talked into enrolling in a program during late enrollment tend to perform poorly. Students in this Learning Biology section showed the biggest drop in their performance following student-centered learning sessions. This result suggests that cooperative learning groups may need a minimum level of initial motivation to be able to benefit from student-centered activities. Our most typical students, those with intermediate grades (TS2 Fig. 1, Panel A; ST1 Fig. 1, Panel B), improved their performance the most following student-centered sessions. Perhaps the most interesting section was TS2 (Fig. 1, Panel A) which didn't respond to mixed teaching, nor to teacher-centered sessions, and then jumped approximately 10% in response to student-centered methods and maintained this higher performance through the final. The section with the highest overall grades (TS1) showed the strongest increases in their grades in response to mixed teaching of the Learning Biology course. While these students may have benefited from the more engaging student-centered sessions when it was a good match for the material, they also were able to stay focused during more teacher-centered sessions which reviewed more content just prior to exams and after content-rich lectures.

The most encouraging result of this study is that sections (ST1, TS2) whose performance on lecture exams increased more in response to student-centered learning enabled students to maintain their improved performance beyond the duration of the student-centered sessions. This suggests that these students have stepped above the specific content addressed in the student-centered sessions to gain a more general understanding of how they learn, which they have then applied during their studies for subsequent exams. One component of student-centered learning is that students organize, evaluate, and enhance their knowledge as they teach their peers. Tessier (2004) found that not only does teaching peers improve the student teachers' understanding of the material that they taught, but it also improved their performance on subsequent exams. As in my study, this indicates that student-centered activities result in meaningful learning at a meta-cognitive level.

Call for Nominations

Bioscene Editorial Board

We are soliciting nominations for four (4) *Bioscene* Editorial Board positions (terms through 2009). Board members provide input in the form of reviews and suggestions concerning the publication ot *Bioscene* to the Editor. Board members are also expected to assist in the solicitation of manuscripts and cover art for *Bioscene*. Board members may be called upon to proofread the final copy of *Bioscene* prior to publication. If you are interested in serving a 3-year term on the Editorial Board, please email the editor, Stephen S. Daggett, at stephen.daggett@avila.edu.

ACUBE 50TH Annual Meeting

October 26-28, 2006
Millikin University
Decatur, IL

The Revolution and Evolution of Biology Education: Where 50 Years Can Take Us

Preliminary Program

Thursday, October 26th

12:30-2:30 PM	**Pre-Conference Field Trip: Mari-Mann Herb Farm** Led by **Maribeth King**, Mari-Mann founder	**Meet at Registration Area 1st Floor Leighty-Tabor Science Building (LTSC)**
3:00-5:00 PM	**Pre-Conference Field Trip: Rock Springs Conservation Area** Led by **Dr. Judy Parrish**, *Millikin University*	**Continue from Mari-Mann or meet at registration area**
3:00 - 5:00 PM	**Steering Committee Meeting**	**LTSC 301**
6:00 - 8:00 PM	**Registration and Reception** *H'ors d'oerves*	*Registration*: **1st floor LTSC** *Reception*: **LTSC 115**
8:00 - 9:00 PM	**Opening Session**	

Welcome to ACUBE:
ACUBE President: **Ethel Stanley**, *Beloit College*
Welcome to Millikin University

Greetings from the Conference Chairpersons
Program Chair: **Conrad Toepfer**, *Brescia University*
Local Arrangements Chairs: **Harold Wilkinson, Neil Baird,** *Millikin University*

OPENING PRESENTATION (Public Welcome to Attend) — **LTSC 001**
Marc Abrahams, Editor
Annals of Improbable Research

9:15 - 10:15 PM	**Steering Committee Meeting**	**LTSC 301**

Friday, October 27th

7:00 AM - 5:00 PM **Registration table**

Time	Event	Location
	(Register, pay dues, buy T shirts, etc.)	**1st Floor LTSC**
7:15 - 8:20 AM	**Hot Breakfast** (Mentors and Mentees meeting or by Interest Group)	**Richards Treat University Center (RTUC): Fireplace and Parquet Rooms**
7:30 - 10:30 AM	**Field Trip: Birding, Macon County Conservation District** Led by **Dr. David Horn**, *Millikin University*	**Meet at Registration Area 1st Floor LTSC**
9:00 AM - Noon and 2:00 - 5:00 PM	**SUSTAINING MEMBER EXHIBITS**	**LTSC 224**
8:30- 10:00 AM	**CONCURRENT WORKSHOP SESSION 1**	
10:00 - 10:30 AM	**POSTER SESSION 1** Refreshments provided	**LTSC 221** **Refreshments: Located between LTSC 224 and 221**
10:30 - 11:15 AM	**CONCURRENT PAPER SESSION 1**	
11:30 - 12:30 PM	**Luncheon and First Business Meeting** *First and Final Call for Nominations!!* *Out of this World Teaching Idea contributions*	**RTUC Fireplace and Parquet Rooms**
12:30 - 1:30 PM	**Luncheon Program** **Celeste Carter**, *Foothills Community College*	**RTUC Fireplace and Parquet Rooms**
1:45 - 2:30 PM	**CONCURRENT PAPER SESSIONS 2**	
2:45 - 3:15 PM	**POSTER SESSION 2** Refreshments provided Posters from morning available for review	**LTSC 221** **Refreshments: Between LTSC 224 and 221**
3:00 - 5:00 PM	**Field Trip 1: Wabash Railroad Depot Antique Mall and Merchant Street shops** Led by **Karen Baird**, *Richland Community College*	
	Field Trip 2: Behind the scenes tour of Scovill Zoo Led by *David Webster*, Assistant Director **Scovill Zoo**	**Meet at Registration Area**
3:30 - 4:15 PM	**CONCURRENT PAPER SESSION 3**	
5:00 PM	**ACUBE Committee Meetings**	

	Web Committee Meeting	**LTSC 202**
6:00 - 7:00 PM	**Social Hour** Cash bar	**RTUC Fireplace and Parquet Rooms**
7:00 - 9:00 PM	**Dinner and Second Business Meeting** (two-minute speeches prior to dinner; balloting after dinner, new officers announced at end of presentation) *The 2006 Out of this World Teaching Idea Award*	**RTUC Fireplace and Parquet Rooms**
8:00 – 9:00 PM	**Dinner Program** **Malcolm Campbell**, *Davidson College* Director, **Genome Consortium for Active Teaching** "Biology education 2056: balancing innovation with improvement."	**RTUC Fireplace and Parquet Rooms**

Saturday, October 28th

7:30 - 8:45 AM	**Continental Breakfast** (by Interest Group)	**RTUC Fireplace and Parquet Rooms**
7:45 - 8:45 AM	**Bioscene Editorial Board Meeting**	**RTUC Fireplace and Parquet Rooms**
9:00 – 11:15 PM and 12:15 – 1:30 PM	**SUSTAINING MEMBER EXHIBITS**	**LTSC 224**
8:45 - 9:30 AM	**CONCURRENT PAPER SESSION 4**	
9:45 – 11:15 AM	**CONCURRENT WORKSHOP SESSION 2**	
11:15 AM - 12:15 PM	**Luncheon and Third Business Meeting** Resolutions: **Brenda Moore**, *Truman State University* Executive Secretary Report: **Tom Davis**, *Loras College* *Bioscene*: **Steve Daggett**, *Avila University* Presidential Address: **Ethel Stanley**, *Beloit College* 2007 Meeting (51st) at Loras College: Program Chair: **Pres Martin**, *Hamline University* Adjournment: **Ethel Stanley**, *President*	**RTUC Fireplace and Parquet Rooms**
12:30 – 1:30 PM	**Steering Committee Meeting** Includes newly elected members!	**LTSC 301**
1:30 – 1:45 PM	**BIOQUEST Workshop Introduction**	**LTSC 001**
1:15 – 4:00 PM	BIOQUEST Workshop Sessions	

Housing Preview
50th Annual ACUBE Fall Meeting
The Revolution and Evolution of Biology Education: Where 50 Years Can Take Us
Millikin University
Decatur, IL

Group rates have been secured for blocks of rooms at six motels/hotels. All rates are per night plus tax. No other discounts apply to group rates. Be sure to mention ACUBE when making your reservations in order to get the group rate. Rooms not reserved by September 26, 2006 will be released to the general public.

Two of the facilities (numbers 5 and 8 on the list) are located less than 3 miles west of campus near the intersection of I-72 and US 36 (actually where US 36 intersects with Wykles Road).

The four other facilities (numbers 2, 6,7, and 11 on the list) are located 6 miles north and east of campus just north of the intersection of I-72 and US 51. A shopping mall and many restaurants are located nearby.

Other lodging possibilities beyond the six with group rates can be found on the website of the Decatur Area Convention and Visitors Bureau: www.decaturcvb.com.

#2
Baymont Inn
5100 Hickory Pt. Frontage Road
Decatur, IL 62526
217-875-5800
rate: $50.00 single

#5
Days Inn
333 N. Wyckles Rd.
Decatur, IL 62522
217-422-5900
rate: $46.95 Dbl/Dbl

#6
Fairfield Inn
1417 Hickory Point Dr.
Forsyth, IL 62535
217-875-3337
rate: $66.00 flat rate (1-4 persons)

#7
Hampton Inn
1429 Hickory Point Dr.
Forsyth, IL 62535
217-877-5577
rate: $66.00 flat rate (1-4 persons)

#8
Decatur Hotel and Conference Center
(formerly Holiday Inn Select)
Route 36 and Wyckles Rd.
Decatur, IL 62522
217-422-8800
rate: $82.00 flat rate (1-4 persons)

#11
Ramada Limited
355 E. Hickory Point Rd.
Decatur, IL 62526
217-876-8011
rate: $69.00 flat rate (1-4 persons)

ACUBE Governance for 2006

President - Ethel Stanley, *Beloit College*
Immediate Past President - Lynn Gillie, *Elmira College*
Executive Secretary - Tom Davis, *Loras College*
Secretary - Laura Salem, *Rockhurst University*
First Vice President (Program Chair) - Conrad Toepfer, *Brescia College*
Second Vice President (Local Arrangements) - Harold Wilkinson, *Millikin University*

Board Members

Hugh Cole, *Hopkinsville Community College*
Melissa Daggett, *Missouri Western State University*
W. Wyatt Hoback, *University of Nebraska- Kearney*
Bobby Lee, *Western Kentucky Community and Technical College*
Brenda Moore, *Truman State University*
Conrad Toepfer, *Brescia College*

Standing Committees

Membership - Bobby Lee, *Western Kentucky Community and Technical College*
Constitution - Margaret Waterman, *Southeast Missouri State University*
Nominations - Conrad Toepfer, *Brescia College*
Internet - Nancy Sanders and Margaret Waterman
Bioscene - Stephen S. Daggett, *Avila University*
Awards - William Brett, *Indiana State University*
Resolutions - Brenda Moore, *Truman State University*
Historian - Edward Kos, *Rockhurst University*

Call for Nominations

President-Elect & Steering Committee Members

ACUBE members are requested to nominate individuals for the office of President-Elect and two at-large positions on the ACUBE Steering Committee. Self nominations are welcome.

If you wish to nominate a member of ACUBE for a position, send a Letter of Nomination to the Chair of the Nominations Committee: Dr. Conrad Toepfer, Brescia University, 717 Frederica St., Owensboro, KY 42301 (270-686-4221, conrad.toepfer@brescia.edu).

ACUBE 50th Annual Meeting

Millikin University
Decatur, IL
October 26-28, 2006

The Revolution and Evolution of Biology Education:
Where 50 Years Can Take Us

Call for Abstracts

From the description of DNA structure in 1953 to the recent discovery of "Hobbits" in Flores, the field of biology has undergone a revolution. At the same time, textbooks for "introductory" biology have rapidly grown from 200 pages to well over 1000 pages. As the amount of information has grown, biology education has evolved to include PBL, case studies, computer simulations, open-ended laboratory projects, and many other innovative methods.

The importance of biology over the last half century is undeniable. For example, 14 of 35 individuals "Who Made a Difference" in a special issue of Smithsonian Magazine are biologists or are influenced by biological topics. As biology continues to blossom, our importance as teachers will make the 2006 Annual Meeting a momentous event for our society. Potential topics for presentations include historical reflections, changes in curriculum, interdisciplinary courses, changes in educational technology, the Web and student learning, seemingly constant threats to teaching evolution, current cutting-edge techniques, and even your newest, untested, and most radical ideas.

Many of you can show us where we came from in the last 50 years, what we should be doing now, and where we should be headed in the next 50 years. Please consider sharing your experiences, your knowledge, and your techniques with us at the 50th ACUBE Annual Meeting in Decatur, IL. Given the importance of this meeting, any type of presentation is welcome. We encourage you to submit a poster, paper or workshop but will gladly try to accommodate additional presentation formats.

Please send a 200-word abstract and the information below as e-mail attachments, by mail, or by fax by May 31, 2006 to

Conrad Toepfer, Brescia University, 717 Frederica St., Owensboro, KY 42301
Ph: 270-686-4221, Fax: 270-686-4222, e-mail: conrad.toepfer@brescia.edu

Proposed Title: ____

Presentation type: _____ 90-min workshop _____ 45-min paper _____ Poster _____ Other (Please explain)
(Rank in order of preference)

Equipment/facility needs:
_____ 35 mm slide projector
_____ Overhead projector
_____ Macintosh projection system
_____ Macintosh computer lab
_____ PC projection system
_____ PC computer lab
_____ Lab benches
_____ Other (explain)

Name of presenter(s): ____

Work address(es): ____
____

Presenter phone number: ____________________ e-mail: ______________________________

NAME: ____ DATE: ____________________

A C U B E

Association of College and University Biology Educators

Formerly the Association of Midwest College Biology Teachers (AMCBT)

TITLE: ____

DEPARTMENT: ____

INSTITUTION: ____

STREET ADDRESS: ____

CITY: ___________________________ STATE: ___________ ZIP CODE: __________

ADDRESS PREFERRED FOR MAILING: ____________________________________

____

CITY: ________________________ STATE: __________ ZIP CODE: ____________

WORK PHONE: _______________ FAX NUMBER: ____________________________

HOME PHONE: _______________ EMAIL ADDRESS: __________________________

MAJOR INTERESTS	**SUB DISCIPLINES:** (Mark as many as apply)	
( ) 1. Biology	( ) A. Ecology	( ) H. Molecular
( ) 2. Botany	( ) B. Evolution	( ) I. Developmental
( ) 3. Zoology	( ) C. Physiology	( ) J. Cellular
( ) 4. Microbiology	( ) D. Anatomy	( ) K. Genetics
( ) 5. Pre-professional	( ) E. History	( ) L. Ethology
( ) 6. Teacher Education	( ) F. Philosophy	( ) M. Neuroscience
( ) 7. Other _____________	( ) G. Systematics	( ) N. Other ____________

RESOURCE AREAS (Areas of teaching and training): ________________________

____

RESEARCH AREAS: ____

____

How did you find out about ACUBE? ___________________________________

Have you been a member before: ___________ If so, when? _________________

DUES (Jan-Dec 2005) Regular Membership $25 Student Membership $15 Retired Membership $5

Return to: Association of College and University Biology Educators, Attn: Tom Davis, Executive Secretary, Department of Biology, Loras College, 1450 Alta Vista, Dubuque, IA 52004-0178