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Bioscene is published in March, May, August and December. Please submit manuscripts by Nov. 1, 2003 for consideration in the next issue.

Cover image: Color images of insect larvae from Appendix 1 (pg 35) of Shaffer et al., *Microbes and Mosquitoes: A Laboratory Exercise to Investigate the Non-target Effects of Bt.*

Articles:

News & Views:

Bioscene: Journal of College Biology Teaching

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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.

Deadlines for Submissions

November 1, 2003 for the December 2003 Issue
February 1, 2004 for the March 2004 Issue

A Dinosaur Trackways Exercise

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Abstract: As part of a course on the biology of dinosaurs (Biology 300, *Dinosaurs: The Course*), our students tested Alexander's (1976) model that the velocity of a bipedal dinosaur is a function of stride length and hip height. To do this students measured their foot length (F) and leg length at the hip (H) and examined those data to test Alexander's assumption that 4F is a good approximation of H, at least for humans. The students then became dinosaurs and made trackways on rolls of unused newsprint approximately 20 meters long. Actual dinosaur (student) velocity was independently measured and compared to predicted velocity using data extracted from the trackway. From these measures Alexander's model was tested. This laboratory exercise worked well and probably has many applications in classes in high school and college. Besides its use in a special class such as this one, other courses that might utilize this exercise include courses in general biology for majors or non-majors, biostatistics, human and vertebrate anatomy, and paleontology.
Key words: biostatistics, bipedalism, dinosaurs, kinesthetic learning, trackways, problem-based learning, vertebrate locomotion,

INTRODUCTION

The subject of dinosaurs is one that is fascinating to students from the grade school level to the college level and beyond. The information that can be extracted from the fossil records is both interesting and amazing. In a course on the biology of dinosaurs (Biology 300, *Dinosaurs: The Course*), we developed a laboratory exercise that employed the 3P's of the Bioquest agenda (Problem posing, Problem solving, Persuasion) to have our students explore bipedal locomotion. Specifically, students tested Alexander's (1976) model that the velocity of a bipedal dinosaur is a function of stride length and hip height: $V = 0.7826 (S^{+1.67}) (H^{-1.17})$, where, S = stride length in meters and H = hip height in meters. In addition to the laboratory exercise, background information, a sample student data, and some materials that support class and laboratory activities regarding dinosaur tracks are provided. This exercise was successful partly because it employed the pedagogies of visual and kinesthetic learning.

THE EXERCISE

The making of a fossil footprint. When an animal steps into soft sediment it leaves behind impressions of its feet (Fig. 1). If an impression dries, it can harden as a footprint (**A**). Erosion or distortion of the footprint may occur at this time (**B**). Sometime later a thin delaminating layer of sediment can cover the trackway; this prevents additional sediment from tides or floods from bonding to the surface of the impression (**C**). Additional sediments are laid down over the footprints (**D**). These sediment layers are slowly lithified, and millions of years later someone finds the deposits and splits them along the bedding plane (delaminating layer), thus separating the layers and revealing the natural cast and the mold of the tracks (**E**).

Trackways. Trackways are composed of a series of footprints that preserves several (at least three) consecutive footprints which, when analyzed provide a good deal of information about the animal that made them (Fig. 2). ***Footprint*** — The imprint left when an animal walks over an impressionable surface such as sand or mud. Foot length is measured from heel to toe (**F**) and foot width at the widest point (**W**) of the impression. The Toe Angle is the angle delimited by the toes on one foot (**Ta**). ***Pace*** — This is the distance between successive alternating footprints: i.e., left-right or right-left steps as measured from the midpoint of the footprint (**P**). The Pace Angle (**Pa**) of successive foot falls and the rotation angle of the foot from the midline (**R**) are also shown in Figure 2. ***Stride*** — The distance from successive prints of the same foot (**S**). ***Trail*** — A series of successive footprints that enables researchers to determine a variety of characters of the animal and its gait. ***Hip Width*** — One may determine information on the size of the animal at its hips, as a point midway between footprints measured perpendicular to the *midline* of the trackway (**D**). ***Hip Height*** —The height of the animal at its hips (not illustrated in figure 2) is measured from the ball of the hip socket to the ground (**H**). The result of these measurements provides a good idea of the animal's size, stance, and gait. Footprints can preserve information about animal behavior, including the following: (1) Did the animal travel alone or in a group (herd)?; (2) Were both young and old present;? (3) Did the animal pause periodically, perhaps rotating to the left or right?; (3) Did the animal drag its tail?; and (4) Did the animal favor one leg or did it limp?

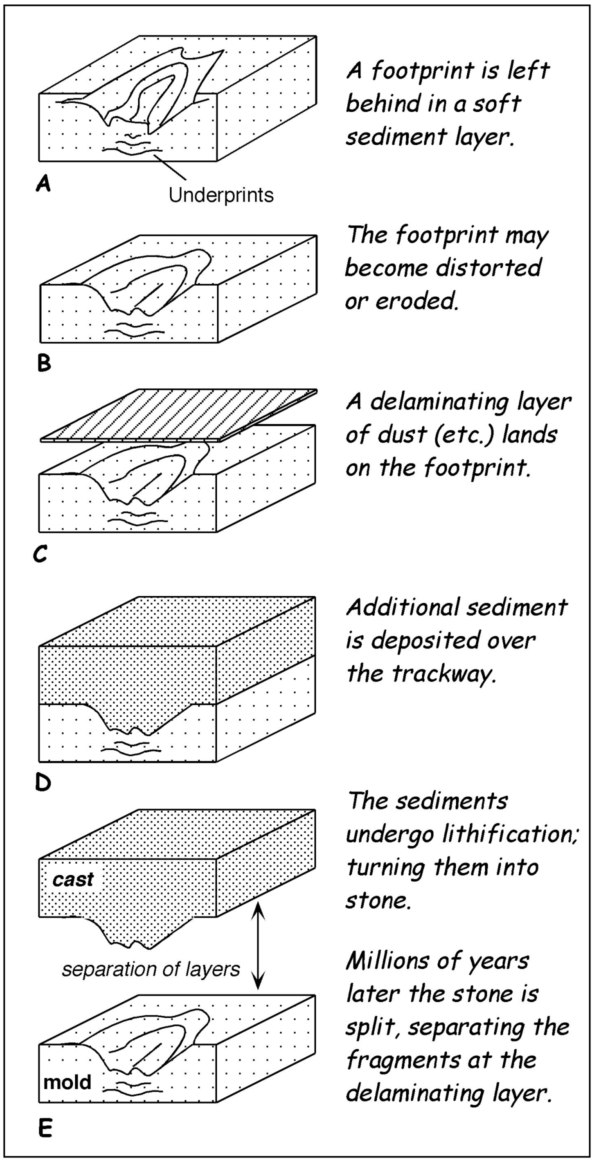

Figure 1. *Formation of tracks. Adapted from several sources: MacDonald 1994; Lockley & Hunt 1995; http://www.stadiumweb.com/reprints/movement.html; http://www.stadiumweb.com/reprints/peterson_ reformat.html; and http://news.bbc.co.uk/1/hi/sci/ tech/1791709.stm*

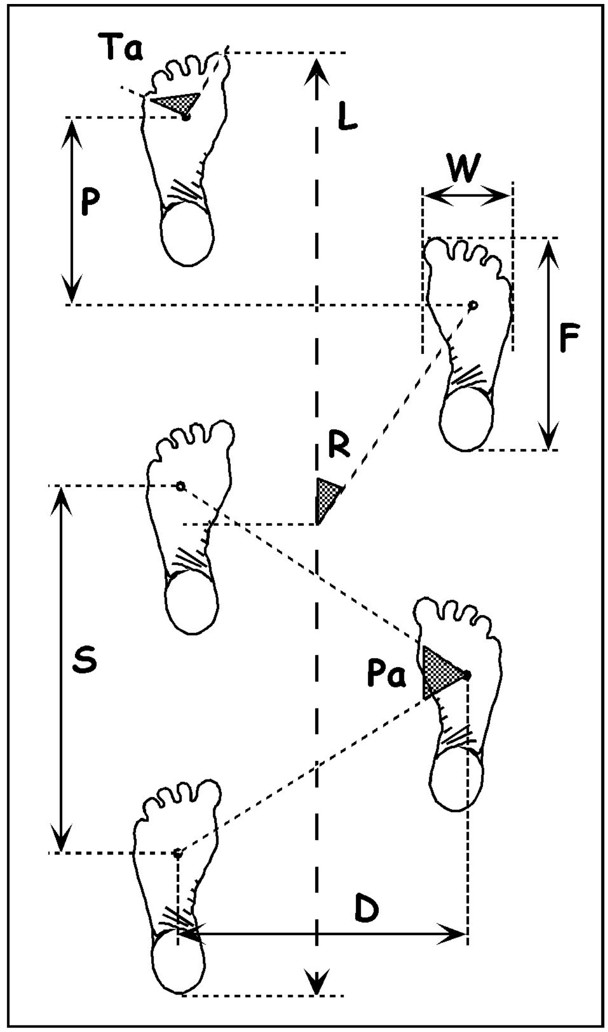

Figure 2. *Trackway characteristics. L, Track length (midline of the trackway); S, Stride; P, Pace of feet; D, Distance between feet; F, Length of foot; W, Width of foot; Pa, Pace angle of feet; R, Rotation angle of foot from midline; Ta, Toe angle. Terminology adapted from MacDonald (1994).*

Alexander's Model. Alexander (1976) estimated the speed of bipedal dinosaurs by studying the dynamics of animal locomotion using strategies that an engineer might use to analyze a problem of mechanics (Watkins 2003). From the trackways he recorded stride length and foot length. Alexander determined that in dinosaurs foot length (F) was a function of leg length at the hip socket (H) such that $F = 0.25H$ ($H = 4F$). Thus, from F he could estimate H, even when fossils leg bones from the animals that made the tracks were not available for examination. He also determined that stride length in meters (S) is a function of leg length (H) at any constant velocity (V). From his analysis Alexander developed an equation that estimated velocity from the values of S and H.

$$V = 0.7826\ (S^{+1.67})\ (H^{-1.17})$$

PROCEDURES

The materials needed for this exercise are really quite straightforward. Each trackway requires at least 20 m of unused newsprint, two flat-bottomed plastic basins, water soluble paint, toweling, masking tape, meter sticks and longer tape measures, protractors, stop watch, and two chairs. (The newsprint was purchased from a local newspaper printer at nominal cost; it came in cardboard rolls in a width of 70 cm and varying lengths.) The exercise was scheduled in Ripon's old gymnasium—it too is now extinct—to provide space needed to permit several teams of students to be engaged simultaneously in trackway production. Groups of three students were expected to set up and run the exercise using the instructions presented below. Students placed a chair at the start of the trackway to provide a seat to facilitate the removal of shoes and socks and a hand support for stepping into the paint basin; at the end of the trackway another chair, along with a wash basin and toweling, provided a convenient station for students to clean up. Masking tape was used to hold the newsprint in place during the exercise.

STUDENT INSTRUCTIONS

Measurements: You will work in groups of three for this exercise. (1) You will measure your foot length (F) and leg length (H) from the hip socket. Faculty will collect the class data and provide you with a summary of the data. In your report you are to test Alexander's assumption that 4F is a good approximation of H, at least for humans. (2) Following the instructions given below you will become a dinosaur making your own trackway.

Trackway Production and Speed: Carefully step into the paint tray, and then onto the paper track. Start to walk using a constant tempo and a comfortable stride length. It does not matter whether your speed is fast or slow, as long as it is comfortable for you. After a few steps have been taken, another student will use a stopwatch and mark the footfall corresponding to the start of timing; the starter will walk behind the track-maker (to avoid any interference with the walker's cadence). Near the end of the run the starter will stop the watch and mark the end of the run (i.e., the last timed footfall). The track-maker will clean up in the wash tub. Set the trackway aside to dry.

Calculations: Measure all the characteristics of your trackway as noted above in the figure entitled Trackway Characteristics (Fig. 2). Report your data to the instructors for tabulation and distribution to the class. Once you receive the data, make the appropriate calculations and make an analysis of Alexander's assumption (H=4F) and his model. You will plot actual velocity as a function of the ratio S:F and the predicted velocity as a function of the actual velocity. This material will be used in your report.

ENRICHMENT QUESTIONS

The following questions were used to develop a class discussion on topics related to the exercise. (1) What characteristics can be determined about an animal from a trackway? (2) What characteristics cannot be determined about an animal from a trackway? (3) Could you outrun a predatory dinosaur, such as *Tyrannosaurus rex* or *Velociraptor*? (4) If the cheetah lived at the same time and in the same place as dinosaurs, could a cheetah capture a dinosaur? Provide supporting data or at least be prepared to discuss the parameters that one would need to know. (5) Estimate the speed of a bipedal dinosaur with a stride length of 1 meter and a leg length of 1.2 meters. (6) How is this sort of work like forensics?

RESULTS

Although the students were enthusiastic about this exercise, their interest waned as the time came to take off their shoes and step into the paint. This was attributed to two facts: (1) The old gymnasium used was chilly; and (2) The students seemed to be embarrassed to take off their shoes and socks. Eventually one of the authors (RLW) had to demonstrate the procedure. Once the ice was broken—so to speak—the students worked enthusiastically on the exercise. A subset of the data that students collected is presented in Table 1. Using the complete data set, the students examined Alexander's assumption that H = 4F. A subset of that analysis is shown in Figure 3. This plot was assigned to be turned in the following class period, at which time the significance of the outcome was discussed. Two weeks after the exercise a complete laboratory report written in scientific format was required. This report included a figure of the predicted student velocity plotted against actual student velocity (e.g., Fig. 4).

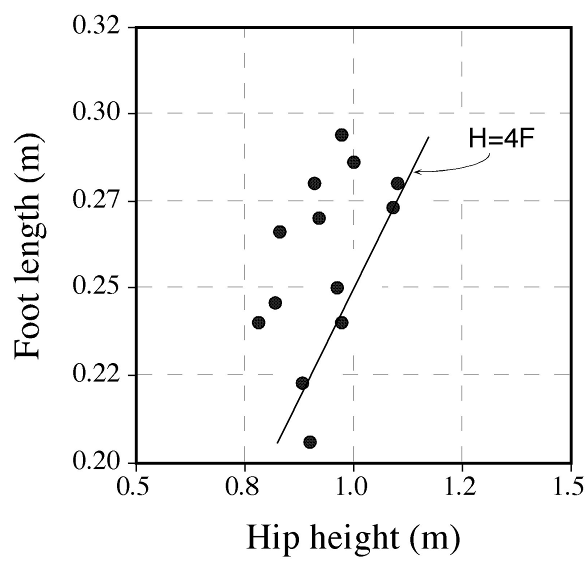

Figure 3. *Sample of the class data plotted to test Alexander's assumption that H = 4F. (Line is H = 4F.)*

Table 1. *Sample of the class data of student trackway footprints[1,2]. (Units are in meters and meters per second.)*

Student	F	H	S	$S^{+1.67}$	$H^{-1.17}$	Predicted Velocity	Actual Velocity
Sample	0.245	0.98	1.31	1.57	1.02	1.26	1.20
1	0.266	0.83	1.53	2.03	1.24	1.97	1.24
2	0.280	1.10	1.43	1.82	0.89	1.27	1.26
3	0.240	0.78	1.21	1.37	1.33	1.43	1.54
4	0.280	0.91	1.32	1.59	1.12	1.39	1.26
5	0.294	0.97	1.29	1.53	1.04	1.24	1.13
6	0.246	0.82	1.20	1.36	1.26	1.34	1.15
7*	0.273	1.09	1.10	1.17	0.90	0.82	2.72
8	0.286	1.00	1.36	1.67	1.00	1.31	0.91
9*	0.223	0.88	2.06	3.34	1.16	3.03	4.60
10	0.270	0.92	1.63	2.26	1.10	1.94	1.30
11	0.250	0.96	1.22	1.39	1.05	1.14	1.15
12	0.206	0.90	0.83	0.73	1.13	1.20	0.63
13	0.240	0.97	1.40	1.75	1.04	1.42	1.33

1 – L (length of the trackway at the midline) was recorded but is not indicated here. W (width of foot); R (rotation angle of foot from midline); Pa (pace angle of feet); D (distance between feet); P (pace of feet) were not recorded to save time during the exercise.

2 – Two students ran resulting in the newspaper slipping on each step; their data points are indicated with an asterisk and open boxes in fig. 4.

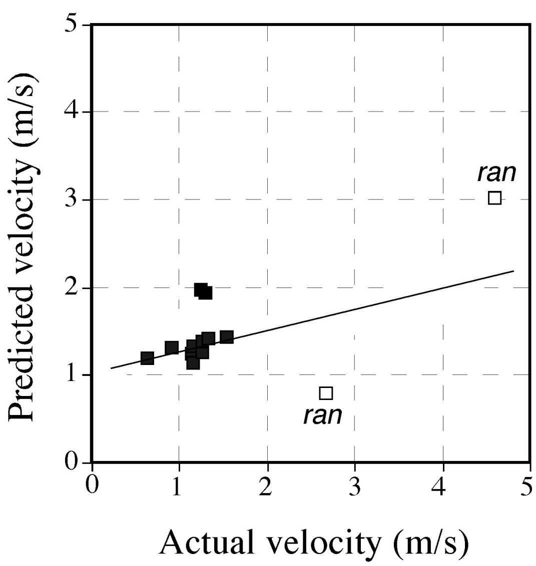

Figure 4. *Sample of the class data in which predicted velocity was plotted against actual velocity. Line is the least squares linear regression of all data points shown in this illustration. Open boxes represent students who ran on the trackway.*

DISCUSSION

The initial reluctance of the students notwithstanding, the experiment was successful. The discussions that developed regarding problem posing and problem solving were especially satisfying. Some of the best questions raised were from the students. Those topics encompassed the following: (1) How can we continue with Alexander's Model when the assumption of H = 4F appears to be flawed?; (2) What does a scientist do with data that lie well outside the bulk of the data set?; (3) Two students ran, can we drop their data points?; and (4) Do different scientific disciplines treat seemingly suspect data differently?

This lab exercise worked well and has many applications from high school through college. Besides a special class such as this one, other classes that might include this exercise include courses in general biology for majors or non-majors, biostatistics, human and vertebrate anatomy, and paleontology.

ACKNOWLEDGMENTS

We thank Marilyn Hanson and Fred Farris for copies of alternate versions of this exercise and our students for allowing us to use them as guinea pigs for this exercise. Margaret Stevens and Margaret Schwemmer improved the manuscript.

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Appendix 1 — Additional Supporting Materials

Additional References

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Videos (this is not an exhaustive list)

- *Curse of T-Rex,* Nova
- *Death of the Dinosaur*, PBS Home Video
- *Dinosaur,* A&E (in four parts)
- *Dinosaur,* Eyewitness
- *Dinosaurs of the Gobi,* NOVA
- *Dinosaurs,* Great Minds of Science
- *Dinosaurs,* Smithsonian Video
- *Fragments of Time,* The New Explorers
- *How to Build a Dinosaur,* Milwaukee Public Museum
- *Skeletons in the Sand,* The New Explorers
- *T-Rex: The ultimate guide,* Discovery

WWW Search — Periodically we have done web searches looking for sites on dinosaur tracks and trackways. The last time we did that was over a several day period late in December of 2002. At that time we performed numerous searches employing a variety of search engines and the keywords "dinosaur tracks," "dinosaur trackways," and "dinosaur human tracks." These searches yielded as few as 37 hits and as many as >25,000. Of course, with the keywords used in these searches we were directed to some sites which provide the so-called evidence offered by creationist for the coexistence of dinosaurs and humans.

Call For Resolutions

The Steering Committee of ACUBE requests that the membership submit resolutions for consideration at the 2003 Annual meeting to the Chair of the Resolutions Committee. Submit proposed resolutions to:

Dr. Richard Wilson, Dept. of Biology, Rockhurst University, 1100 Rockhurst Rd
Kansas City, MO 64110, Phone (846) 501-4048, wilson@vax1.rockhurst.edu

Call for Nominations

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Incorporating Bioinformatics into the Biology Classroom through DNA Sequence Analysis

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Abstract: The area of bioinformatics is rapidly evolving due to daily discoveries in the areas of molecular biology and computer technology. As such, it is important that students are introduced to this new field. This activity gives students an opportunity to investigate how bioinformatics can be used to make direct comparisons between DNA sequences. The students will gather a variety of DNA sequences for a gene; analyze the sequences by comparing the GC content, codon usage, melting temperatures; and perform a phylogenetic analysis.

Keywords: Bioinformatics, Nucleotides, Calmodulin, Codon, Melting Temperatures, and Amino Acids

INTRODUCTION

One of the hottest areas of science today is the field in which biology, information technology, and computer science are merged into a single discipline called bioinformatics. This field enables the discovery and analysis of biological data including nucleotide and amino acid sequences that are easily accessed through the use of computers. There has been an explosive amount of biological information in a large number of databanks, which necessitates the use of computers for retrieval, analysis, and storage. It is important for educators to provide new challenges for their students that incorporate the advancements in the areas of molecular biology, the human genome project, and computer technology. These databanks contain a wealth of information that can be used effectively as an educational tool. The following activity uses bioinformatics to investigate the nucleotide, codon, and melting temperature differences for one gene found in several different organisms. The intention is not only to expose the students to the databanks but for them to understand how four simple nucleotides (GTCA) can influence some basic properties of DNA. Phylogenetic analysis of these sequences will also provide insight into the evolutionary relationships among the organisms. Specifically, the nucleotide frequencies between organisms and the codon usage for that gene within each organism will be examined.

Only 20 amino acids are encoded by the 64 available codons in the DNA repertoire. For protein coding areas of the genome, the degeneracy of the code has allowed DNA to mutate certain nucleotide sites without a resulting change in the coded amino acid. Genomes have diverged during evolution, resulting in clear-cut differences in their nucleotide composition, such as their G-C content. The complete genome sequences of many organisms are now available. This permits comprehensive comparative analysis of these genomes. Recent investigations have reported differences in the frequency of nucleotide occurrence (Sharp et al., 1995; Knight et al., 2001; Marais & Duret, 2001). Variation can be shown between protein coding or non-coding DNA and tRNA genes as well as regions within the same gene. One difference is exhibited in nucleotide frequency biases. Synonymous codons, coding for the same amino acid, are often used with very different frequencies (Sharp, 1990; Anderson and Kurland, 1990; Sharp and Cowe, 1991). Positions that undergo synonymous substitutions are called silent sites. The amino acid alanine can be used as an example as it is coded 4 different ways (GGA, GGC, GGG, and GGT). However, the frequency of each codon for alanine varies between organisms. Silent sites found in protein-coding genes can support two possible evolutionary processes: mutational biases and natural selection. For example, in yeast, the codon usage patterns are determined by natural selection for specific codons that are highly efficient in translation by the most abundant tRNAs. Codon usage patterns vary greatly within the human genome; however, natural selection does not seem to play a role, which suggests that mutational patterns demonstrate regional preferences within the genome (Sueoka & Kawanishi, 2000).

Purpose of this activity:

1. To help students gain experience navigating through DNA Databanks.
2. To illustrate the different %G-C content present in the same gene throughout various organisms.
3. To demonstrate the variations in codon usage for each amino acid among organisms.
4. To enable students to make the connection between nucleotide frequency, codon usage, and melting temperatures.
5. To build proposed Phylogenetic Trees based on a single gene from different organisms.

The calmodulin gene sequence will be used for the purposes of this exercise. Calmodulin is found in all eukaryotic cells. Each calmodulin molecule has four calcium binding sites, binding of calcium induces a conformational change in this molecule. This conformational change alters its interaction with its target enzymes. This gene was chosen because of its relatively small size, 450 nucleotides in length. Instructors are strongly encouraged to choose the gene of interest for their students to investigate. Other good choices include smaller genes such as catalase, insulin, and cytochrome C oxidase subunit II.

MATERIALS

Each student (or pair of students) will need access to the Internet and a word processing program. The databanks needed for this activity are provided in Table 1. The students should construct a table in a word processing program, where they can enter their data. An example is shown in Table 3. Students should have a basic understanding of how to navigate between the Internet and their data table in order to efficiently record their findings.

***Table 1**. Databanks used for this activity.*

National Center for Biotechnology Information (NCBI) http://www.ncbi.nlm.nih.gov
The Sequence Manipulation Suite http://www.ualberta.ca/~stothard/javascript/
Nucleotide Frequency Program http://vector.cshl.org/bioinformatics/dna_characteristics.htm
DHPLC Melt Program http://insertion.stanford.edu/melt.html
Biology Workbench http://workbench.sdsc.edu/
Cold Spring Habor Sequence Server http://vector.cshl.org/bioserver
Codon Usage Database http://bioinformatics.org/sms/codon_usage.html
T-COFFEE Sequence Alignment http://www.ch.embnet.org/software/TCoffee.html

PROCEDURES

Part I -- Sequence Identification and Retrieval. Access the National Center for Biotechnology Information (NCBI) in order to search the Genbank databank for the gene of interest (calmodulin). Table 2 lists the accession numbers used in this activity. Enter the accession number for an organism in the blank where it states "Search nucleotide for ______", then hit *go*. The screen that comes up should have the accession number on it with a brief description of the gene. Click on the accession number; this will connect the reader to a screen with a large amount of information, including both the nucleotide and amino acid sequences. Be careful of the DNA sequences listed on this screen because they often contain the nucleotide sequence upstream and downstream of the gene itself. On this screen there should be a *CDS* link to click on; this will give you the actual coding sequence for the gene of interest.

Table 2. The scientific and common names of the organisms used in this activity. The accession numbers provided correspond to the calmodulin gene for each organism.

Scientific Name	Common Name	Accession Number
Paramecium tetraurelia	Paramecium	S68025
Mus musculus	House mouse	NM_007590
Glycine max	Soybean	L01430
Arabidopsis thaliana	Thale Cress	NM_114249
Oryza sativa	Rice	AF042840
Caenorhabditis elegans	C. elegans(worm)	NM_070985
Xenopus laevis	African clawed frog	K01945
Homo sapiens	Human	M27319
Metridium senile	Brown sea anemone	AB063183

After clicking the *CDS* link for the calmodulin gene, scroll down to the bottom of the screen, highlight and copy the DNA sequence. After the sequence has been copied access The Sequence Manipulation Suite, click on the *Filter DNA* link in the top left corner. Clear the text box that comes up on the screen, paste your sequence and hit submit. This will remove all the numbers from the sequence. If these numbers are not removed, the programs will not operate properly. Copy this sequence, paste it into a word processing program, and make sure to label the organism's name next to the sequence. Follow the above procedures for all the accession numbers, until all the sequences are pasted into the word document. Next, go to the Nucleotide Frequency Program**.** Scroll down the page until a window appears in which to paste the sequence. After pasting the sequence into the window, select *All*. The screen that results provides a large quantity of information including the gene sequence, sequence length, and the %A-T/G-C composition. For basic instructional purposes, there are three pieces of information students should retrieve, the percent composition of A+T, the percent composition of G+C, and the length of the sequence. Copy this information into the table previously constructed in the word document.

Part 2 -- Sequence Analysis. As each sequence is found, fill in the table (Table 3) with the information. Notice the range of % G-C content between the sequences. For example, *Paramecium* contains 35.33% G-C and rice is composed of 60.67% G-C.

Denaturation of double-stranded DNA occurs when the hydrogen bonds of the structure break, the structure unwinds, and the strands separate. This can be induced by heat or chemical treatment. Denaturation as a result of heat is referred to as melting. Since G-C base pairs have one more hydrogen bond than A-T pairs they are more stable when heated. Thus, a sequence of DNA that has a greater % G-C than % A-T requires higher temperatures for denaturation. The point at which 50% of the DNA is unwound or denatured is called the melting temperature (***Tm***). Analysis of melting profiles provides a characterization of DNA and an alternate method of estimating the base composition of DNA. Students should be able to predict the order in which the DNA denatures based on their % G-C findings for each sequence.

To find the actual melting temperatures, enter the sequences into the DHPLC Melt Program. Here again, copy and paste each individual sequence into the Melt program. Make sure that the entered sequence does not have any numbers in it; the first line should only have a > symbol, while the actual sequence should begin on the second line. Once the sequence is properly entered, click the *Submit* button. The program will provide the melting temperature for each sequence entered. Record the ***Tm*** findings in the chart to determine if the previously made predictions were correct.

Table 3. Data retrieved about the composition of the calmodulin gene sequences in the organisms used for this activity.

Common Name	Gene Length	%AT	%GC	Melting Temperature (°C)
Paramecium	450	64.67	35.33	55.0
House Mouse	450	48.00	52.00	60.5
Soybean	450	51.56	48.44	59.75
Thale Cress	450	50.89	49.11	60.00
Rice	450	39.33	60.67	62.75
C. elegans	450	48.22	51.78	61.00
African clawed frog	450	55.11	44.89	59.5
Human	450	58.22	41.78	58.00
Brown sea anemone	450	56.22	43.78	59.25

Part 3 -- Sequence Comparisons. Accessing a number of programs including the T-COFFEE Sequence Alignment site and Biology Workbench can permit direct comparisons of DNA sequences. For the purposes of this activity the Biology Workbench site was used. The user must step up an account (which is free), but this allows the user to be able to save his/her data on this site to access later. To enter each sequence of interest log onto the Biology Workbench site, select *Session Tools* and *create a new session* and name it *Calmodulin* for this activity. Select *Nucleic Tools* and scroll down to *Add New Sequence.* Create a file for each organism's sequence. Select the sequences that you wish to align by clicking the box next to each file, and then select the *ClustalW* option. There will be some options that the user can change in the alignment or the user can stay with the default settings; select *Submit* at the bottom of the page. Select *Import Alignments*, this will save this alignment in a single file for further analysis. The asterisks found in the results represent where the sequences were the same for the sequences. Direct comparisons and alignments can now be made between the sequences. The students can calculate which percent of the two sequences were identical. Figure 1 shows the results of comparing the DNA sequences for calmodulin from human and *C. elegans.* There were 346 asterisks representing conserved sequences out of the 450 nucleotides; this results in 76.88% of the sequences being identical. The students can make additional comparisons between sequences, and compare all nine sequences together to determine the overall percent identity between the sequences.

```
human          ATGGCTGATCAGCTGACCGAAGAACAGATTGCTGAATTCAAGGAAGCCTTCTCCCTATTT
c.elegans      ATGGCCGATCAACTGACCGAGGAGCAAATTGCCGAGTTCAAGGAGGCATTCAGTTTGTTC
               ***** ***** ******** ** ** ***** ** ******** ** ***    * **

human          GATAAAGATGGCGATGGCACCATCACAACAAAGGAACTTGGAACTGTCATGAGGTCACTG
c.elegans      GACAAGGACGGCGATGGCACAATCACCACCAAGGAATTGGGAACTGTTATGCGGTCTTTG
               ** ** ** *********** ***** ** ****** * ******** *** ****  **

human          GGTCAGAACCCAACAGAAGCTGAATTGCAGGATATGATCAATGAAGTGGATGCTGATGGT
c.elegans      GGACAAAATCCGACTGAAGCCGAGCTTCAGGACATGATCAACGAAGTGGACGCTGACGGA
               ** ** ** ** ** ***** **  * ***** ******** ******** ***** **

human          AATGGCACCATTGACTTCCCCGAATTTTTGACTATGATGGCTAGAAAAATGAAAGATACA
c.elegans      AACGGAACCATCGATTTCCCAGAGTTCTTGACGATGATGGCCCGCAAGATGAAGGACACG
               ** ** ***** ** ***** ** ** ***** ********  * ** ***** ** **

human          GATAGTGAAGAAGAAATCCGTGAGGCATTCCGAGTCTTTGACAAGGATGGCAATGGTTAT
c.elegans      GACAGTGAGGAGGAGATTCGTGAGGCGTTCCGAGTTTTCGACAAGGACGGAAATGGCTTC
               ** ***** ** ** ** ******** ******** ** ******** ** ***** *

human          ATCAGTGCAGCAGAACTACGTCACGTCATGACAAACTTAGGAGAAAAACTAACAGATGAA
c.elegans      ATCTCGGCCGCTGAACTGCGCCACGTCATGACCAACTTGGGAGAGAAGCTAACGGACGAA
               ***   ** ** ***** ** *********** ***** ***** ** ***** ** ***

human          GAAGTAGATGAAATGATCAGAGAAGCAGATATTGATGGAGACGGACAAGTCAACTATGAA
c.elegans      GAGGTCGACGAGATGATCCGTGAAGCCGATATCGACGGAGATGGACAAGTCAATTATGAG
               ** ** ** ** ****** * ***** ***** ** ***** *********** *****

human          GAATTCGTACAGATGATGACTGCAAAATGA
c.elegans      GAGTTCGTCACCATGATGACAACCAAGTAA
               ** *****    ********  * ** * *
```

Figure 1. *CLUSTALW results using human and C. elegans sequences for calmodulin. The asterisks (*) represent where the sequences are identical.*

Part 4 -- Phylogenetic Trees. Following the alignment of the sequences, the same program used in Part 3 can be utilized to construct proposed phylogenetic trees. Select *Alignment Tools* and choose the aligned sequences by clicking the box next to the file name. Next just click the *Drawtree* or *Drawgram* option. Drawtree draws a rooted tree, while the Drawgram program diagrams an unrooted tree. A rooted phylogenetic tree shows all descendents of a single original ancestor (Figure 2A). Alternatively, an unrooted tree shows the relationships the information has with each other but not necessarily to a common ancestor (Figure 2B).

Sequence information can help in depicting evolutionary relationships based on molecular evidence. These relationships have occupied biologists since Darwin. Phylogeny is the field that tries to show the relationships among populations, species, individuals, or genes. In 1835 Darwin studied the Galapagos finches, noting differences in the shape of their beaks and how that correlated with their diet. Today, the best approach for phylogenetic analysis among species would be through DNA sequence comparisons. Using this approach it is possible to differentiate selective from non-selective change by using the third position in codons and the proportion of synonymous to non-synonymous codon substitutions.

Part 5 -- Codon Analysis. The codon usage of the corresponding coding sequences for the calmodulin genes selected can be determined by using the Codon Usage Database. Nucleotides are read in sets of three by the translation apparatus to determine which amino acid to add to the growing peptide chain. This group of three nucleotides is referred to as a codon. While two organisms may be relatively similar in nucleotide sequence or closely related to one another evolutionarily, the way nucleotides are read as codons for amino acids can vary a great deal. For example, the codon GTA in one organism could be predominantly used for insertion of a valine while in another organism GTG could be used primarily to code for the same amino acid. This can be done simply by cutting and pasting the nucleotide sequence of interest from the NCBI database into a codon usage bioinformatics website.

Access the Codon Usage Database; this results in a page with a text box on top containing a nucleotide sequence with a sample codon usage chart underneath. This sample sequence should be erased. Enter >human (for example) on the top line, skip to the second line and then paste the sequence of interest into the text box. Once this is done, hit *Submit*. This leads to the codon usage table. Table 4 shows the comparisons of the most commonly used form of the codon for many amino acids.

After making a few preliminary observations, pose some hypotheses about the differences in the codon usage between the organisms. For example, since the *Paramecium* sequence is composed of 64.67% A-T, one could hypothesized that the codons for the amino acids in this sequence will most likely end with an A or a T instead of a G or C. In contrast, rice is only 39.33% A-T so the codons for the amino acids in this sequence will most likely end in a G or C. Notice in Table 3 that the *Paramecium* uses the GCT codon for alanine most frequently while rice primarily uses the GCC codon. It has been known that

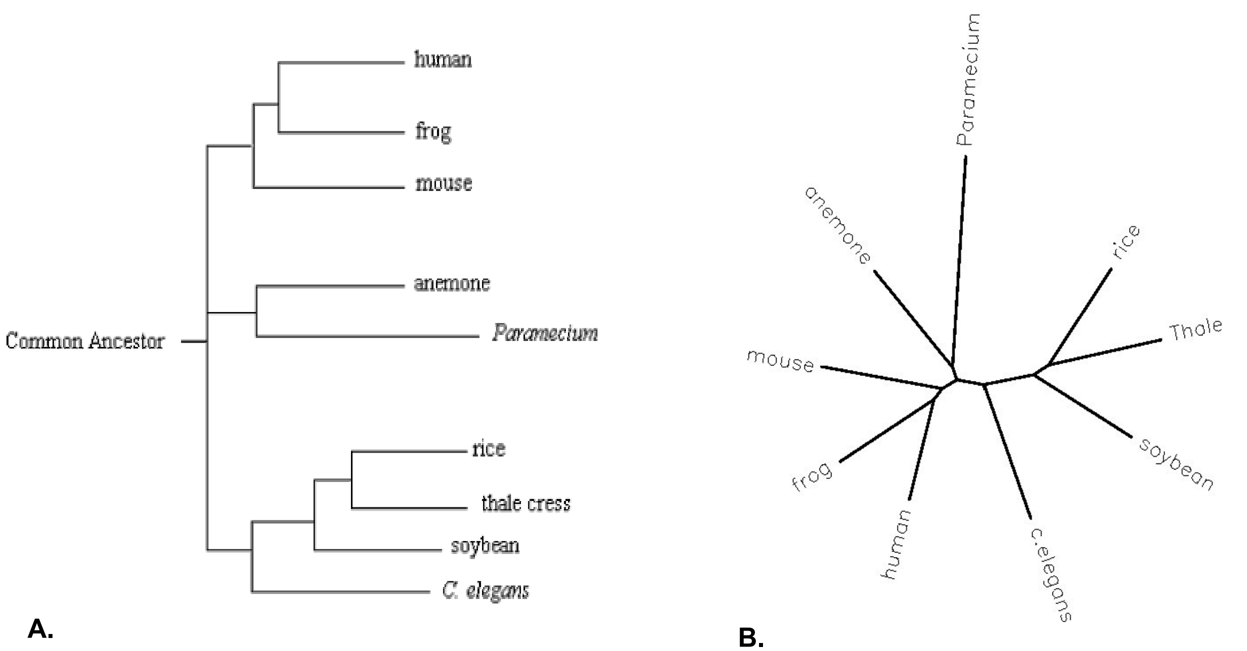

***Figure 2**. A. Rooted phylogenetic tree representing the proposed evolutionary relationships among the organisms from a common ancestor B. Unrooted phylogenetic tree showing the proposed relationship among the DNA sequences for each organism.*

Table 4. Some of the codons used most frequently in the calmodulin gene for organisms studied in this activity.

Amino Acid	*Paramecium*		House Mouse		Soybean		Thale cress		Rice		*C. elegans*		African Frog		Human		Sea Anemone	
	Preferred codon	% use	Preferred codon	% use	Preferred codon	% use	Preferred codon	% use	Preferred codon	% use	Preferred codon	% use	Preferred codon	% use	Preferred codon	% use	Preferred codon	% use
Ala	GCT	91	GCC	45	GCT	60	GCA GCT	30 30	GCC	64	GCC	60	GCA GCT	45 45	GCA GCT	45 45	GCT	70
Asn	AAC	67	AAT	67	AAT	57	AAC	86	AAC	100	AAT AAC	50 50	AAC	67	AAC AAT	50 50	AAT	83
Gly	GGA	73	GGC GGG	36 36	GGC GGG	40 40	GGG	50	GGC	60	GGA	73	GGC	45	GGA GGT	36 36	GGT	45
Glu	GAA	91	GAG	81	GAG	80	GAG	63	GAG	95	GAG	71	GAA	76	GAA	95	GAA	52
Arg	AGA	100	AGA CGA CGT	33 33 33	CGA	40	CGT	40	CGC	60	CGT CGC	33 33	AGG CGT	33 33	AGA CGT	33 33	AGA CGA CGT	33 33 33
Leu	TTA TTG	33 33	CTG	78	CTC	45	CTT	45	CTC	64	TTG	50	TTA CTT	33 33	CTA	33	CTT	33
Met (start)	ATG	100	ATG	100	ATG	100	ATG	100	ATG	100	ATG	100	ATG	100	ATG	100	ATG	100
Pro	CCA CCT	50 50	CCA CCC	50 50	CCA CCT	50 50	CCA CCG	50 50	CCG CCA	50 50	CCG CCA	50 50	CCA CCT	50 50	CCC CCA	50 50	CCT CCC	50 50
Thr	ACA	56	ACC	42	ACC ACA ACT	33 33 33	ACA	44	ACC	78	ACC	50	ACA	50	ACA	50	ACA ACC	50 50
Ile	ATT	56	ATT	75	ATC ATT	43 43	ATC	86	ATC	100	ATC	75	ATC	50	ATC	63	ATT ATC	50 50
Lys	AAA	75	AAG	100	AAG	90	AAG	70	AAG	90	AAG	100	AAG	75	AAA	63	AAA	67
Val	GTT	57	GTG GTC	43 43	GTT	38	GTC	50	GTC	75	GTC	57	GTT	43	GTC	57	GTC	43

alternative synonymous codons are not used randomly, but in the least by mutational biases. A clear example of this can be found within the bacterial species *Streptomyces*, which has a genomic G-C content of 70%. The codons within this species almost entirely end in a G or C (Wright & Bibb, 1992) suggesting a codon preference. The G-C content within a genome will influence the synonymous codon usage. Synonymous codon usage seems to enhance translational efficiency based on natural selection in a wide variety of both prokaryotes and eukaryotes. This can raise questions to consider; such as what role this might play in the production of transgenic organisms.

Curriculum Applications

The following activity was initially introduced to Bio 101 General Biology students, most of who were freshmen in college with a wide variety of majors and science background. It has proved to be an effective educational tool that combines computer technology, databases, and software programs in order to investigate basic DNA properties. Components of this lesson have also been modified to challenge the level of the students involved. For example, this lesson was changed to challenge General Genetics students, most of whom were juniors. These students were provided with the information necessary to access the necessary databases and instructed in the use of the software. The General Genetics students basically used only the codon analysis section of this exercise to determine if codon usage patterns vary only between genomes or among genes within a genome as well. The students were free to choose both the genes and genomes of interest for their analysis. Since each activity has step-by-step guidance; it has been presented at hands-on Teacher-to-Teacher Workshops for the area biology teachers. The feedback from the teachers was favorable. Some of the teachers stated that they only used parts of this activity to enhance their classroom lesson, while other teachers shared that they had used the entire activity plus added to it. For example, the students can run their sequences through a restriction enzyme program (http://www.firstmarket.com/cutter/cut2.html) which states where the restriction enzyme cut sites within the DNA sequence are located. The teachers had their students use this program to determine the fragment sizes of DNA being produced by a particular enzyme and then following it up with the students predicting how these fragments would migrate through an agarose gel during gel electrophoresis. Another good site for sequence analysis is the Cold Spring Harbor Sequence Server.

CONCLUSIONS

Overall, these analyses give students a chance to navigate through and become familiar with various databanks that are available for DNA sequence analysis. In addition, students gain an understanding of the similarities and differences for one gene obtained from various organisms through the use of bioinformatics tools. As bioinformatics becomes a more visible area of study, students will be exposed to it and have a deeper appreciation for it.

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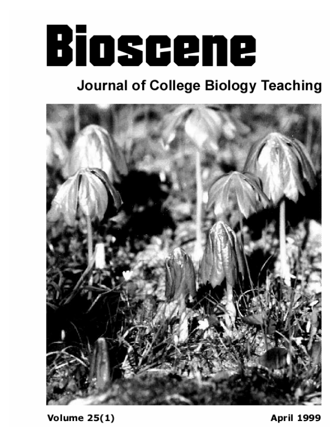

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Helping Students Succeed in Introductory Biology Classes: Does Improving Students' Attendance Also Improve Their Grades?

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Abstract: In one section of an introductory biology course I stressed the value of class attendance for academic success, and in another section I did not. The section in which attendance was stressed was characterized by higher average rates of attendance and higher average grades in comparison to the section in which attendance was not stressed, despite the fact that students received no credit for attending class. The correlation between higher attendance and higher grades was also strong for individual students, regardless of the section in which they were enrolled. These data are discussed relative to students' expectations, attitudes, and performance in the course.

Key words: attendance, attitudes, grades, introductory biology

INTRODUCTION

Several researchers have tried to use students' personality traits and other subjective factors to predict students' academic success. For example, Barney, Fredericks, and Fredericks (1984) studied how students' grades are affected by factors such as anomy, personality, stress, anxiety, and social class; and Baird (1984) documented how personality, aptitude, and scores on intelligence tests affect students' grades. Although these and similar studies have often produced interesting and informative results, they have not been overly helpful to teachers wanting to answer students' most basic question – namely, "What can I do to succeed in this course?"

My answers to this question have often been truisms such as "study hard" and "read the assigned chapters." In response, students often reported that they *did* study hard and *did* read the assigned chapters. Perhaps they did, but such self-evaluations are often highly unreliable (Sappington, Kinsey, and Munsayac, 2002). Unlike students' self-reported data regarding study-habits and reading compliance, class attendance is a course-related behavior that can be easily, accurately, and objectively measured.

Science professors have long been puzzled by students' low rates of class attendance. Students pay large amounts of tuition to enroll in courses that they must pass to graduate from college, and universities hire award-winning teachers, build lecture halls and labs, and spend large amounts of money on furnishings, equipment, and supplies to ensure that students will be able to learn about science. Nevertheless, many students do not show up for class.

Absenteeism is a significant problem at many colleges and universities (Romer, 1993), especially in introductory science courses (Friedman, Rodriguez, and McComb, 2001). As Romer (1993) has noted, "A generation ago, both in principle and in practice, attendance at class was not optional. Today, often in principle and almost always in practice, it is" (p. 174). This absenteeism occurs despite the fact that less than one-third of faculty feels that students are well prepared for college (Thomas, 2002).

Although several studies have focused on why students skip class (Devadoss and Foltz, 1996; Friedman, Rodriguez, and McComb, 2001), there have been surprisingly few studies of how attendance relates to academic performance. Moreover, these studies have often excluded first-year students (Devadoss and Foltz, 1996; Hancock, 1994; Van Blerkom, 1996), been restricted to elite, "highly competitive" schools (Romer, 1993), been based on small samples (Immerman, 1982), and produced conflicting conclusions. For example, some studies have concluded that high rates of class attendance correlate positively with high grades (Brocato, 1989; Jones, 1984; Launius, 1997; Romer, 1993; White, 1992; Wiley, 1992), while others have concluded that students' grades are not related to class attendance (Berenson, Carter, and Norwood, 1992; Hammen and

Kelland, 1994; Thompson and Plummer, 1979). Some researchers have even suggested that mandatory attendance policies could worsen students' grades (Hyde and Flournoy, 1986). As St. Clair (1999) has noted, "research has not consistently revealed a positive relationship between attendance and achievement" (p. 172).

This study examined 1) how class attendance relates to course performance and 2) if an ongoing emphasis on the empirical value of class attendance for course performance changes students' attendance and grades. An attempt was made to address a variety of questions. For example, do students understand the value of attendance to grades? Does coming to class make a difference? If so, what can be done (short of giving students points for merely showing up) to increase attendance? And if attendance improves, do grades improve?

METHODS

The course and students. This study was done during 2002 in a large introductory biology course at the Twin Cities campus of the University of Minnesota. Both sections of the four-credit course (GC 1131: Principles of Biological Science) were taught by the same instructor, in a similar way (e.g., same syllabus, textbook, sequence, pedagogical techniques), and in the same large lecture hall. The study included two sections enrolling a total of 301 students having an average age of ~20 years, an average ACT composite score of 20, an average high school rank of 51%, and an average course load of 15 semester-hour credits. The composition of the classes was, on average, 53% male and 47% female, and was ethnically diverse: 17% African American, 2% American Indian, 16% Asian and Pacific Islander, 4% Chicano/Latino, and 61% Caucasian/other. These traits did not vary appreciably in either of the sections of the course. Both sections were taught near mid-day.

Attendance, exams, and grading. Class attendance was recorded in 88% of the courses' classes. All exams covered material presented both in class and in assigned readings from the required course-textbook. Missing classes did not preclude any student from making an A; that is, students could have earned an A on each exam if they had read and understood the readings assigned in the textbook. No grades were "curved"; students were not allowed to retake any exams; and there were no extra-credit projects. Course grades were based entirely on students' abilities to demonstrate their mastery of the course's academic content on multiple-choice and essay exams. No points were awarded for excellent attendance, and no points were deducted for poor attendance. Students who withdrew from the course or failed because of academic dishonesty were not included in this study.

The University of Minnesota has a concise, one-sentence policy regarding attendance: "Students are expected to attend all meetings of their courses" (Policies, 2002). The course syllabus added the following statement about the importance of attendance for academic success; "You are expected to prepare for and attend every class. This is important because class attendance is usually a strong indicator of course performance." On the first day of class, this part of the syllabus was discussed with and emphasized to students in both sections of the course. In the section of the course hereafter referred to as the "low attendance" section (N = 154 students) students were told on the first day of class that 1) they were expected to attend class, 2) high attendance increases the probability of earning a high grade in the course, and 3) low attendance increases the probability of earning a low grade in the course. Nothing else was said to these students about the importance of attendance for academic success for the remainder of the semester.

In the section of the course hereafter referred to as the "high attendance" section (N=147 students), students ere told on the first day of class that 1) they were expected to attend class, 2) high attendance increases the probability of earning a high grade in the course, and 3) low attendance increases the probability of earning a low grade in the course. They were shown a graph similar to the one shown in Figure 1, which depicted how grades correlated with attendance in the course during previous semesters. The effect of different rates of attendance on the probabilities for making various grades in the course was discussed. Copies of the graph were distributed to students and it was suggested that they write an analysis of the data presented in the graph. At least once per week for the rest of the course, they were shown the graph in the minutes before the beginning of class.

Students' expectations, attitudes, and grades. Students' expectations and attitudes about class attendance and course grades were obtained by administering a written survey at the beginning of the first day of class. The survey was administered prior to the discussion of grading, attendance policies, and course syllabus. During the third week of class another survey was administered in which students were asked if they were receiving academic credit for attendance in other courses in which they were enrolled. During the last week of class another written survey was administered seeking students' opinions of the course, their performance, their attendance, their studying outside of class, and their purchase and use of the course textbook. The surveys were not analyzed until the final grades had been submitted.

RESULTS

Students' predictions, expectations, attitudes, and performance. The predicted (P) and actual (A) average attendance, average grade, attendance distribution, and grade distribution for students in the high-attendance and low-attendance sections of the course are shown in Table 1. On the first day of class, more than 80% of the students believed they would attend 81-100% of the classes, about 15% believed they would attend 61-80% of the classes, and only about 2% believed they would attend 41-60% of classes. No student in either section believed he/she would attend less than 40% of classes (Table1). On average, students believed they would attend 87% of classes. More than 90% who expected to make an A also expected to attend all classes, and more than 80% who expected to make a B also expected to attend all classes (Table 2). These percentages were not significantly different in the two sections of the course.

On the first day of class, about 55% of the students believed they would make an A in the course, about 40% believed they would make a B, and only 5% believed they would make a C. No student in either section believed he/she would make less than a C (Table 1). These percentages were not significantly different in the two sections. Virtually all students expected to make an A or B in the course regardless of how often they expected to attend class (Table 1). On average, students in both sections fell short of their predicted grades and attendance rates (Table 1)

Students' attitudes about attendance and grades on the first day of class are presented in Table 3. The majority of students (65-97%) believed they should get points for attending class, they would make a higher grade if they attended class regularly, they should would "make up " missed classes by reading the textbook and/or a classmate's notes, and their decision to attend class would be influenced by whether they received credit for attending. About 40% of the students believed that excused absences would not affect their grades as much as unexcused absences. Somewhat less than half the students believed their grades should be based only on what they know and learn in the course (Table 3). The percentages shown in Table 3 were not significantly different between the high-attendance and low-attendance sections.

Table 1*. The predicted (P) and actual (A) average attendance, average grade, attendance distribution, and grade distribution in the high-attendance, low-attendance, and the combined sections of an introductory biology course. All numbers in the table are percentages. Attendance was based on measurements taken in 88% (21 of 24) classes*

	COMBINED		LOW		HIGH	
	P	A	P	A	P	A
Average attendance	87	64	86	59	87	70
Average grade	90	69	90	64	91	73
Attendance distribution						
Attended 80-100% of classes	83	32	85	24	82	41
Attended 60-79% of classes	15	26	14	27	16	25
Attended 40-59% of classes	2	27	1	18	2	16
Attended 20-39% of classes	0	12	0	16	0	8
Attended 0-19% of classes	0	13	0	15	0	10
Grade distribution						
A	55	9	55	6	56	12
B	40	28	41	24	39	32
C	5	28	4	28	5	28
D	0	20	0	19	0	21
F	0	15	0	23	0	7

Table 2*. How students' expectations on the first day of classes for final course grades relate to their expected rates of course attendance.*

Expected Grade	Expected Attendance (%)					
	81-100		61-80		41-60	
	H	L	H	L	H	L
A	93	91*	5	7	2	2
B	82	84	17	15	1	1
C	12	14	88	85	0	1

*For example, 91% of the students in the low-attendance section who expected to make an A in the course expected to attend 81-100% of classes. No student expected to make less than a C, nor did they expect to attend less than 60% of classes.
Tae and low-attendance sections of an introductory biology course as expressed on the first day of class. Numbers in the table reflect the T-percentages of students who agreed with the statements. None of the differences between the sections were statistically significant.

The relationship of course grades and class attendance is shown in Figures 1-3. In the graph representing the combined sections (Fig. 1), the correlation coefficient r was 0.76362, and the coefficient of determination (r^2) was 0.583 (i.e., attendance accounted for 58.3% of the variation in grades). In the graph representing the high-attendance section (Fig. 2), the correlation coefficient was 0.75482, and the coefficient of determination (r^2) was 0.570 (i.e., attendance accounted for 57.0% of the variation in grades). In the graph representing the low-attendance section (Fig. 3), the correlation coefficient was 0.76152, and the coefficient of determination (r2), was 0.589 (i.e., attendance accounted for 58.0% of the variation in grades). All of these correlations are statistically significant ($p < 0.001$)

A survey taken during the last week of class provides input from students in the two sections concerning attendance, whether they had purchased and read the textbook, the percent reading assignments they completed, the number of hours they studied per week, and the relative difficulty of the course as compared to their other courses (Table 4). Students in both sections reported similar rates of textbook purchase, course attendance relative to other courses, hours spent studying outside of class, and reading assignment completion. The only response in which there was a significant difference involved their view of the difficulty of the course. Significantly more students in the high-attendance section believed the course had been easier than they had expected (Table 4).

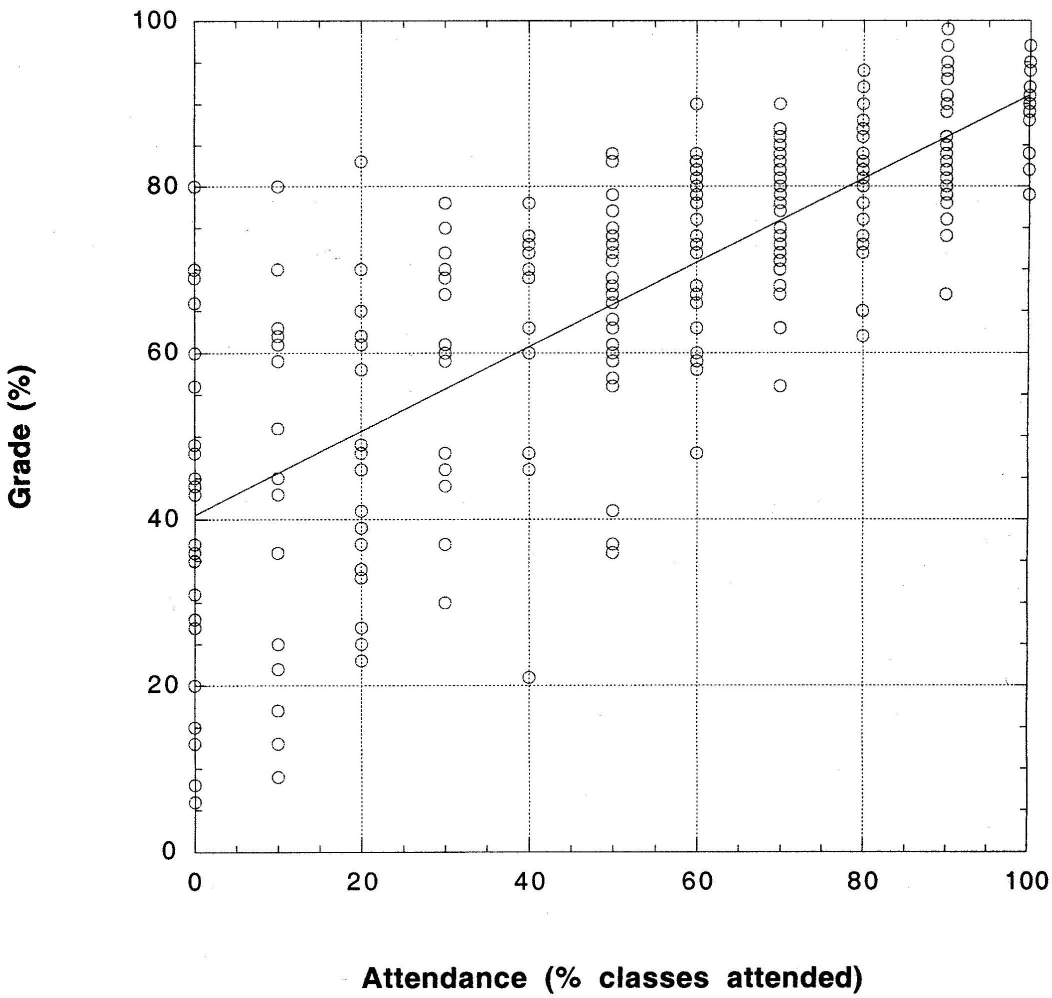

***Figure 1**. The relation of class attendance to course grades in a large introductory biology class. The equation for these data is y = 40.563 + 0.50501x, and the correlation coefficient (r) = 0.76362.*

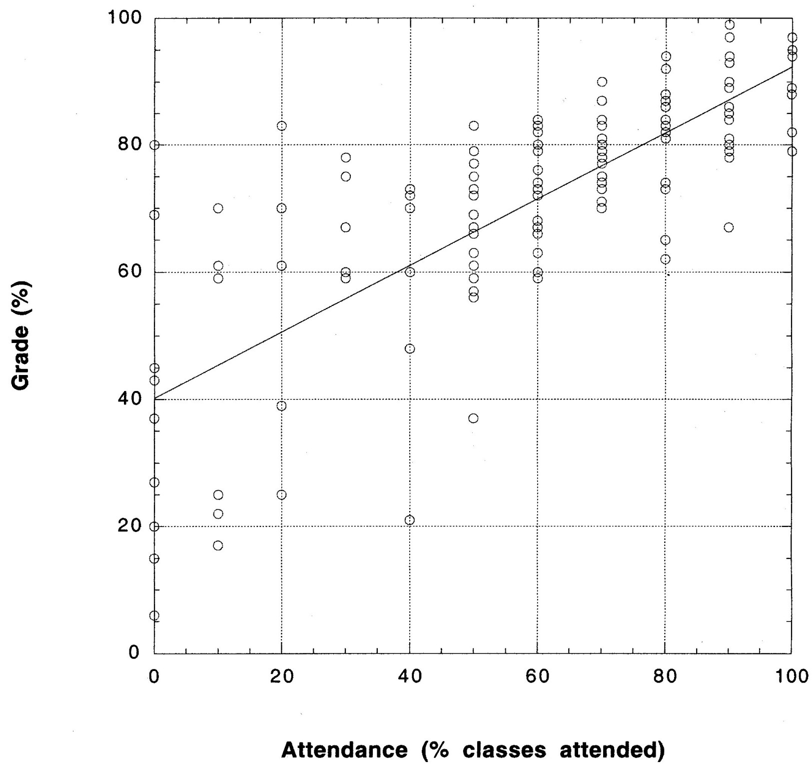

Figure 2. *The relation of class attendance to course grades in a large introductory biology class in which the empirical importance of class attendance was stressed throughout the course. The equation for these data is y =40.213 + 0.52208 x, and the correlation coefficient (r) = 0.75482.*

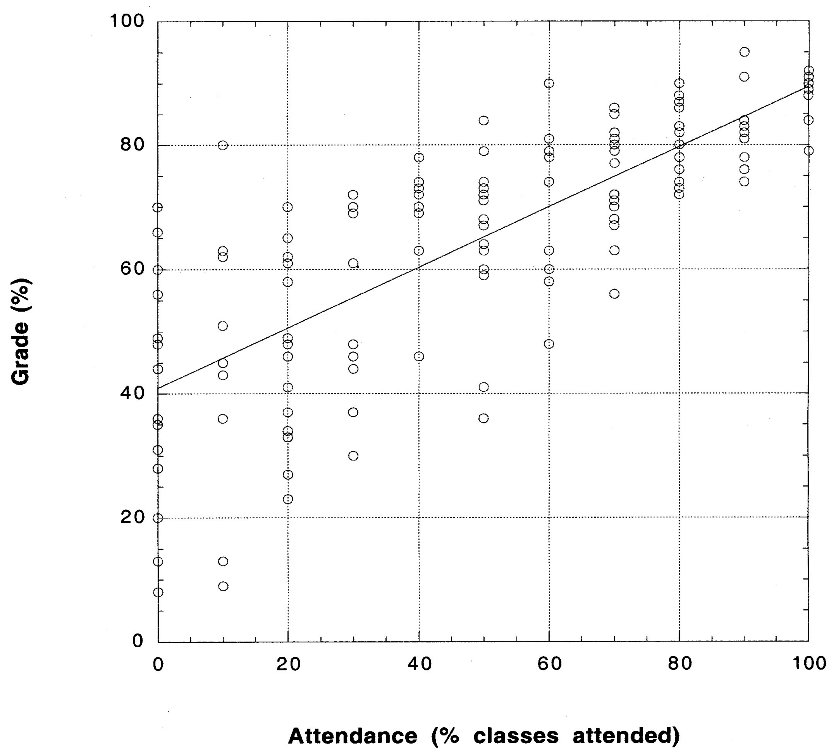

Figure 3. *The relation of class attendance to course grades in a large introductory biology class in which the empirical importance of class attendance was not stressed. The equation for these data is y =40.903 + 0.48584 x, and the correlation coefficient (r) = 0.76152.*

Table 3*. Students' opinions about class attendance and grades in high-attendance and low-attendance sections of an introductory biology course on the first day of class. Numbers in the table reflect the percentages of students who agree with the statements. None of the differences between the sections were statistically significant.*

STATEMENT	HIGH	LOW
My final grade should be based primarily on what I learn, not on whether I attend class.	48	44
I should get academic credit for attending class.	71	68
Effort should be a direct part of my grade in this course.	88	89
Grades should be curved if students do poorly on exams.	93	93
If attendance is not a direct part of my grade, there's not much reason to attend class.	9	11
I can learn as much by "cramming" for a test (e.g., not studying for a test until the night before a test, and then studying many hours) than by studying every day.	26	23
I will purchase and read the course textbook.	96	94
Attendance should be a direct part of my grade in this course.	65	69
If I attend class regularly, I should make at least a B in the course.	76	74
My decision to attend class will be influenced by whether I receive credit for attending class.	68	65
I took a biology course in high school.	97	99
I'll probably make a higher grade in this course if I attend class regularly.	95	97
If I miss class I will "make up" the class by reading the textbook and/or by obtaining a classmate's notes.	89	92
In college, it is not as important to attend class as it was in high school.	20	24
An excused absence will not affect my course grade as much as an unexcused absence.	43	42

Table 4*. Students' evaluation, at the end of the course, of their performance in high-attendance and low-attendance sections. Numbers in the table are percentages.*

Statement	High	Low
I attended this class ____ my other classes.		
More often than	33	29
Less often than	2	3
About the same as	65	68
I bought the course textbook.	97	99
I read about ____% of the reading assignments.	59	58
I studied about ____ hours per week outside of class.	4	5
This course has been _____ than/as I thought it would be.		
harder	43	54
easier	9	2
about the same difficulty	47	44

DISCUSSION

No significant academic or demographic differences in the two populations of students could be determined on the first day of classes. Virtually all (i.e., 97-99%) students had taken a biology course in high school, and students in each section had, on average, similar expectations and attitudes about attending class, buying and reading the course textbook, reading assignments, studying for exams (i.e., the effectiveness of "cramming" as compared to studying every day), making up missed classes, and the importance of excused as compared to unexcused absences. These results suggest that the different performances of the two sections were probably not due to academic or demographic differences existing on the first day of class.

Students' expectations. On the first day of classes, students in both sections are highly confident that they will make high grades and attend class regularly (Tables 1,2). Students in both sections believed they would make a higher grade if they attended class regularly (Table 3). These results indicate that students understand that high grades are associated with high attendance. They believe they will make higher grades if they come to class regularly and make up the classes they miss.

Most students failed to meet their first-day expectations regarding attendance and course performance. For example, 1) far fewer students who believed that they would make an A or B actually made an A or B, 2) far more students made a C, D, or F than students predicted, and 3) the mean final grades in the course (69%) was far lower than the mean grade (90%) that students had predicted (Table 1). These results indicate that students' expectations on the first day of classes are often unrealistic. These high expectations may result from a mistaken assumption that college courses have the same academic rigor as high school courses, in which grades are higher than ever (Henry, 2001, Moore, 2002) despite the fact that students are studying "far less" than ever (Young, 2002, p. 36). When these students enroll in college, they often feel that the same effort that produced their high grades in high school entitles them to the same high grades in college (Young, 2002).

Although most students in both sections of the course did not meet their first-day expectations for class attendance and academic performance, a larger percentage of students met first-day expectations in the high-attendance section. Students in the high-attendance section of the course had higher average grades and higher attendance rates than did students in the low-attendance section of the course. These results suggest that a thorough, empirical, and ongoing emphasis on the correlation between class attendance and academic success (i.e., as was done in the high-attendance section of the course) can help introductory biology students meet their academic (i.e., grade) and behavioral (i.e., class attendance) expectations.

Attendance and grades. In both sections of the course, high attendance increased students' probability of earning high grades, and low attendance increased students' probability of earning low grades. For example, the average attendance rate in the high-attendance section was 70% as compared to 59% in the low-attendance section. This difference in attendance correlated positively with the average grade in the high-attendance section of 73% as compared with 64%, in the low-attendance section. These data emphasize the importance of class attendance for the academic success of introductory biology students.

In both sections of the course, attendance accounted for about 58% of the variation in grades. These data are similar to those of Wiley (1992), who reported that students' absences explained 57% of the variation in students' grades in an introductory business course, and Street (1975), who reported that student absences explained 52% of the variation of students' grades. Launius (1997) reported correlation coefficients (r) for attendance and grades ranging from 0.24 to 0.46. , class attendance is important for students' academic success.

Although most introductory biology students believe that attending class will improve their grades, they may base this belief on the view that students should get academic credit for attending class (Table 3). Almost three-fourths of the students in this study reported that they were receiving academic credit for attending most of the classes in which they were enrolled. In such classes, there is a clear and direct reward for attendance. This is what most students expect; most students believe that 1) attendance and effort should be a direct part of their grades, and 2) they are entitled to at least a B if they attend class regularly (Table 3). Similarly, most students' decisions to attend class may be influenced by whether they receive academic credit for attending class; less than half of students believe that their grades should be based on what they learn rather than on whether they attend class (Table 3). Similar results have been reported by Launius (1997) for students taking introductory psychology. When students do not get points for attending class (as in this study), they apparently become skeptical of the value of class attendance, and their attendance drops. This is consistent with the report of Friedman, Rodriguez, and McComb (2001) that the top reasons for missing class (excluding illness) are that attendance does not influence students' grades, that attendance is not taken, that absences are not noticed, and that course-material is available from other non-classroom sources (e.g., textbooks, web sites). When students miss classes, their grades suffer (Figs. 1-3; also see Brocato, 1989; Jones, 1984; Launius, 1997; Romer, 1993; White, 1992; Wiley, 1992).

Differing rates of class attendance may affect the "chemistry" of a class. Brauer (1994) has reported that poor attendance can "create a 'dead,' tiresome, unpleasant classroom environment that makes [students who do attend class] feel uncomfortable" (p. 206), and White (1992) has observed that absences can diminish a class's overall "well-being" (p. 13). In this study, however, the similar slopes of lines in Figures 1-3 indicate that students who attended similar percentages of classes earned similar final grades, regardless of the attendance rates of their classmates (i.e., regardless of whether they were in the high-attendance or low-attendance section of the course). Thus, although different rates of overall class attendance may affect the dynamics of some classes (Brauer, 1994; White, 1992), the different rates of overall class attendance did not alter the importance of class attendance for the academic success of individual students in this study (Figs. 1-3).

Several studies have investigated how attendance is affected by incentives such as points, food, and money (e.g., Robertson, Johnson, and Bethe, 1980; Beaulieu and Sheffer, 1985; Kopelman and Schneller, 1983). In this study, the incentive for students was indirect. Instead of receiving cash or movie tickets for coming to class, students were repeatedly reminded that coming to class regularly would improve their chances of earning a higher grade. As noted in Figures 1-3, this approach was effective.

Class attendance is important for success in introductory biology classes (Figs. 1-3; Brocato, 1989; Jones, 1984; Launius, 1997; Moore, 2003; Romer, 1993; White, 1992; Wiley, 1992). Data presented in Figures 1-3 suggest that we can improve some students' attendance and learning by emphasizing the empirical relationship between attendance and grades. This emphasis on attendance does not ensure academic success, but it does increase the *probability* of academic success. Nevertheless, correlation is not causality; attendance alone doesn't guarantee that a student is learning. This is illustrated by the fact that some students who came to class regularly did poorly in the course. However, the more typical result is that failure follows students who – despite our best efforts – choose to skip classes. As Thomas and Higbee (2000) have noted, "The best ... teacher, no matter how intellectually stimulating, no matter how clear in providing explanations and examples, may not be able to reach the high risk freshman who has no real interest in learning ... and will certainly not be successful with the student who fails to show up for class" (p. 231). Students have a responsibility for their own success, and effort usually brings reward. To again quote Thomas and Higbee (2000), "Nothing replaces being present in class" (p. 229).

The strong correlation between class attendance and academic success is also valid in high school. For example, Peterson and Colangelo (1996) showed in a large study of high school students that poor students skip or are tardy for many more classes than are good students. Thus, emphasizing the value of class attendance may be an effective way for advisors, professors, and counselors to improve students' chances for academic success.

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Microbes and Mosquitoes: A Laboratory Exercise to Investigate the Non-target Effects of Bt

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ABSTRACT: The use of insecticides to manage problem insect species has resulted in ecological damage because most insecticide classes result in mortality of non-targeted species including vertebrates. Recent advances in molecular biology techniques have allowed the development of insecticides from microorganisms, which offer the possibility of reduced non-target effects. One such insecticide designed to control mosquito larvae is a toxin from *Bacillus thuringiensis israelensis* (Bti). This product can be purchased commercially in two forms, bits that dissolve quickly and dunks that are designed to dissolve slowly. In this laboratory exercise, students test the sensitivity of various aquatic insect larvae to the effects of Bti from both products. Students compare survivorship of mosquito larvae and other aquatic insects exposed to four concentrations of Bti to determine lethal concentrations and possible non-target effects. This exercise is appropriate for classes such as general biology, environmental biology, and microbiology. It teaches students about the use of natural insecticides and is both safe and inexpensive.

KEY WORDS: insecticide, non-target effects, *Bacillus thuringiensis*, aquatic insects

INTRODUCTION

Insects are the most numerous, diverse, and prolific organisms on this planet. Due in part to their huge numbers, insects can exert a significant impact on humans. Although many insects are beneficial, insects are believed to be responsible for as many as one half of all human deaths, diseases, and deformities (Daly *et al*., 1998), and destruction of one third of all human food (Estruch *et al*., 1996). For these reasons, insecticides in the United States are a five billion dollar a year industry. Chemical insecticides do a reasonably good job at controlling the insect population, but they also have effects on non-target species, including predatory insects and spiders, which are natural enemies to pest species. Different insecticides pose different levels of risk to non-target organisms ranging from vertebrates to invertebrates. For example, insecticides, such as DDT, have substantial effects on vertebrates and invertebrates alike (Fry, 1995). This creates a problem in attempting to determine if the benefits of using insecticides outweigh the negative impacts the insecticide will have on the environment.

Scientists have been working to develop insecticides that have minimal non-target effects. One of the best natural insecticides they have found is a toxin produced by the bacterium *Bacillus thuringiensis* (Schnepf *et al*., 1998). The bacterium *B. thuringiensis* is commonly found in the soil. This bacterium produces a crystal toxin (Bt toxin), which is lethal to certain insect larvae after they have ingested it. The Bt toxin is activated in the midgut of the larva if the pH is between 9.5 and 10. Once the toxin is activated, it binds to protein receptors in the insect gut and begins to punch holes, creating osmotic instability in the insect. This leads to the death of the larva. While non-target effects of Bt toxin first arose as an issue as a consequence of work in Cornell University in 1999 (Losey *et al*., 1999), it is clear that Bt toxin has few non-target effects because in order for it to be activated, the gut has to be alkaline and contain specific protein receptors found only in larvae of specific insect orders (flies, beetles, and moths).

Scientists have been able to find 100 different toxins in *B. thuringiensis* (Schnepf *et al*., 1998). Different strains of the bacterium produce different toxins, which are lethal to different insects. One strain of *Bacillus*, *B. thuringiensis israeliensis* (Bti), is active against dipterans like mosquitoes and black flies. These Bti crystals can now be purchased to control mosquito populations in small ponds or birdbaths. The Bti toxin can be purchased in cakes or "dunks" and bits. The dunks slowly dissolve, and mosquito larvae that eat a high enough concentration of the solubilized Bti toxin will die. Bits dissolve more quickly, killing mosquito larvae within 24 hours, but they do not provide longer lasting protection, as do the dunks.

In this exercise non-target effects of these commercially available Bti products are examined and the concentration of Bti toxin required to kill the mosquito larvae is determined. Because biological organisms vary in their ability to withstand toxins, including Bti, the Lethal Time to kill 50% (LT_{50}) of the mosquitoes is estimated. Non-target effects are identified by testing the effects of Bti on other common aquatic insect larvae.

MATERIALS AND METHODS

Materials (per group)

- Larval forceps
- Bt mixtures
- 20 plastic cups
- Insect larvae (mosquitoes, black-flies, May flies, midges, and caddis-flies)
- Sharpie markers
- Graduated cylinder
- 1 ml pipette and bulb
- Pasteur pipette and bulb

Collecting aquatic insects.

Although this exercise can be easily conducted using mosquito larvae purchased from Carolina Biological Supply, part of the students' enjoyment for this laboratory is to go to the field and collect their own test organisms. Several methods are possible for collecting insect larvae. These include the use of aquatic dip nets and kick seines. It was determined that the easiest and most reliable method to isolate aquatic larvae was to pick up pieces of submerged rocks and examine them directly for attached insect larvae. The larvae should be carefully dislodged from the rocks with fingernails or larval forceps (available from BioQuip or Carolina Biological). Larval forceps allow the insects to be gently dislodged without damaging them. The collected larvae should be placed in a bucket with stream or lake water and transported back to the lab. (Many of these larvae are sensitive to chlorine, so stream or lake water is best to maintain the larvae.) Mosquito larvae can be collected seasonally from still waters.

Several types of larvae can be obtained from most locations. Expertise in identifying the insects is not required as long as the students can group them as different types. The collected types should be placed into orders based on their physical characteristics. For these experiments aquatic insect larvae belonging to the Orders: Diptera (true flies), Ephemeroptera (Mayflies), Odonata (dragonflies and damselflies), and Trichoptera (caddis-flies) have been used. Aquatic insect orders are easily identified using a number of readily available keys. Check the included photographs of the most common orders used in these experiments as examples of what you might find. In addition, the short text description of key characteristics can be used to identify the order of the larvae collected.

Treating the larvae with Bti toxin.

1. Form groups of 2-4 students.
2. Each group will be testing the sensitivity of mosquito larvae and one other aquatic insect type. See table in appendix for identification of common larvae.
3. Acquire 24 plastic cups. Label the plastic cups according to which type of larvae they will contain and the appropriate Bti concentration (0 $\mu g\ ml^{-1}$, 1 $\mu g\ ml^{-1}$, 10 $\mu g\ ml^{-1}$, and 100 $\mu g\ ml^{-1}$). Each group will do the experiment in triplicate to allow for experimental error and variability among insects. Pool class data to compare each concentration for each type of insect larva.
4. Place 20 ml of lake water into each of the cups.
5. Standard Bti solutions have been prepared for you. Pipette 1 ml of the appropriate Bti stock solution into each of the cups. These will give final concentrations of 0 $\mu g\ ml^{-1}$, 1 $\mu g\ ml^{-1}$, 10 $\mu g\ ml^{-1}$, and 100 $\mu g\ ml^{-1}$.
6. Place one larva into each cup and record the time the larva was placed into the solution.
7. Larvae should be checked as often as possible (two-hour intervals work best). At the minimum, larvae should be rechecked 24 hours post exposure to identify whether the larvae are still alive. Living larvae will respond by movement when the cup is gently agitated. Larvae that do not move should be considered dead and the time of death should be entered in Table 1.
8. Once your data have been compiled, compare your results with that of the other groups in the class.

Table 1. *Number of insect larvae remaining alive after being exposed to 4 concentrations of Bti.*

Insect: Mosquito larvae

Time of Exposure	Concentration of Bti			
	0 µg ml^{-1}	1 µg ml^{-1}	10 µg ml^{-1}	100 µg ml^{-1}
1 hour				
4 hours				
12 hours				
24 hours				

Insect:

Time of Exposure	Concentration of Bti			
	0 µg ml^{-1}	1 µg ml^{-1}	10 µg ml^{-1}	100 µg ml^{-1}
1 hour				
4 hours				
12 hours				
24 hours				

Answer the following questions:

1. Which concentration(s) of Bti killed mosquito larvae? Estimate the time necessary for death of half the test subjects (LT_{50}) for each concentration of Bti.
2. Did the Bti toxin affect your other test insect? Why is it important that Bti toxin work on specific insects?
3. Could we have done this lab using a chemical instead of a biological insecticide? What would you expect to happen with a chemical insecticide?
4. Supposing that the Bti toxin kills black flies and mosquitoes but not beetles, caddis-flies, or mayflies, how would you explain the results?
5. Did you see any killing of non-target organisms? If so, how do you explain these results?

SAMPLE RESULTS AND DISCUSSION

For this experiment, the efficacy of bits on two target organisms, mosquitoes and black flies (Figure 1), and two non-target organisms, caddisflies and midges was tested (Figure 2). As can be seen in Figure 1, the bits killed mosquito larvae quicker than the black fly larvae. Mortality was seen with the black flies, but it took longer for the larvae to die. For mosquitoes, the LT_{50} for the bits was 2 hours for 100 µg ml^{-1}, 5 hours for 10 µg ml^{-1}, and about 20 hours for 1 µg ml^{-1} Bti. For black flies, it was 7 hours for the highest concentration, and between 9 and 20 hours for lower doses. In the non-target organisms, some mortality was seen, but this mortality was probably due to other factors besides Bti toxin, such as injury during capture and handling. These data provide an opportunity to discuss variability and experimental error with students.

For example, students should discuss whether the observed mortality of non-target species showed any consistent pattern. If mortality were approximately equal and thus unrelated to exposure dose the students should conclude that larvae were dying from some other factor. Similarly, if student groups obtain mortality in control groups of mosquitoes, discussion should focus on possible explanations (e.g. injuries, contaminated water, starvation). Students should also discuss how to handle their estimates of LT_{50} if the controls died. For example, if one of the two control mosquito larvae died, should the students adjust the experiment to examine only larvae that fit the proper control results? Should the students disregard all results because some mortality factor is responsible for death of one fourth of study organisms? This unknown mortality factor could cause more death in the presence of Bti. Such a relationship is termed "synergism" and is defined as the action of two factors taken together is greater than the effect of either taken alone.

In an alternative experiment, students compared the efficacy of killing between the material in dunks and bits. The dunks were pulverized with a mortar and pestle and added to the containers with larvae at the same concentrations as used with the bits. Although manufacturers indicated that the bits worked more quickly than the dunks, no significant differences between the two treatments were observed (data not shown). This was probably due to the fact that the dunk was pulverized and the Bti toxin was released into solution; whereas, manufacturers suggest adding the whole dunk to the body of water which will very slowly dissolve releasing small amounts of Bti toxin at a time.

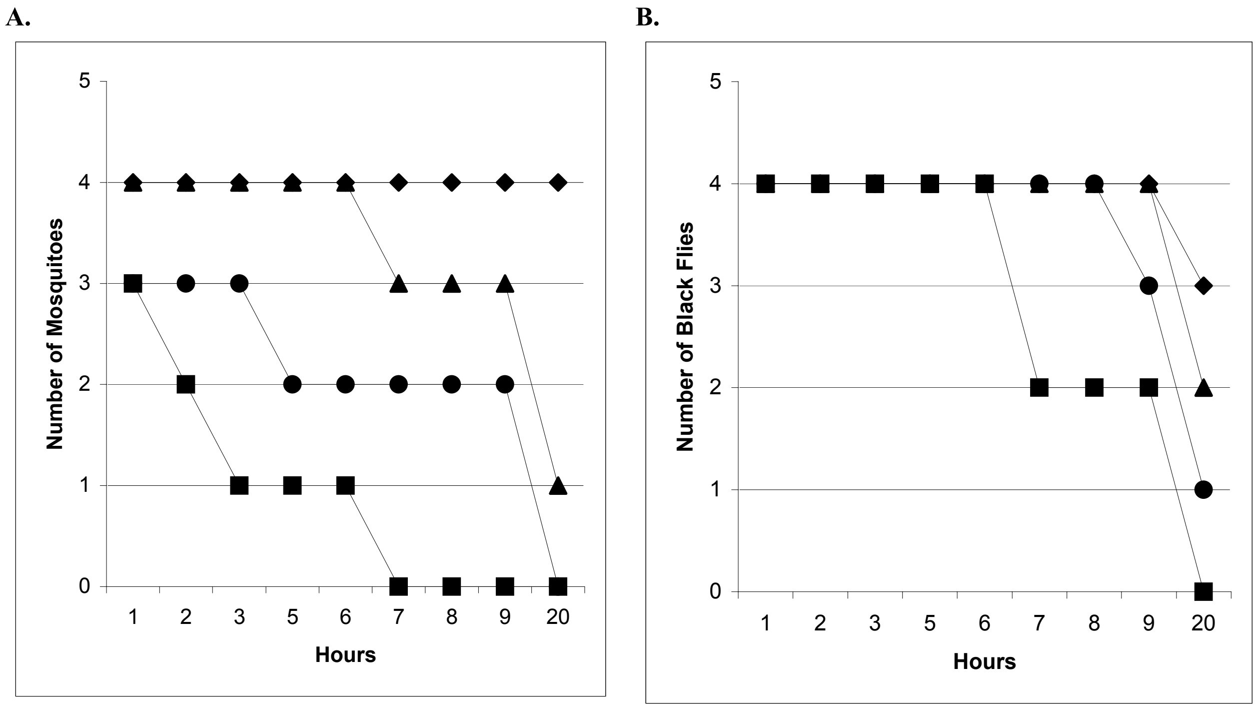

__Figure 1__. Number of target insect larvae (a. Mosquitoes; b. Black Flies) remaining alive after exposure to varying concentrations of Bti. Symbols: ◆, No Bti added; ▲, 1 µg ml^{-1} Bti; ●, 10 µg ml^{-1} Bti; ■, 100 µg ml^{-1} Bti.

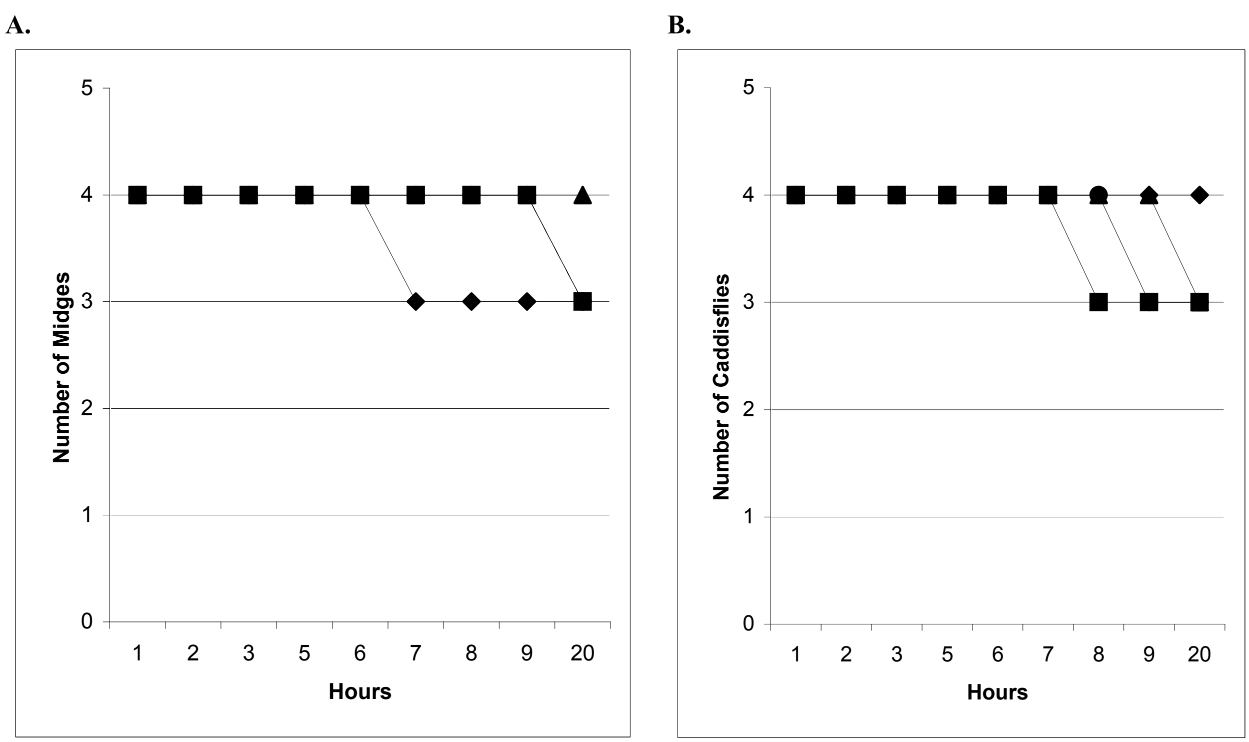

__Figure 2__. Number of non-target insect larvae (a. Midges; b. Caddisflies) remaining alive after exposure to varying concentrations of Bti. Symbols: ◆, No Bti added; ▲, 1 µg ml^{-1} Bti; ●, 10 µg ml^{-1} Bti; ■, 100 µg ml^{-1} Bti.

CONCLUSIONS

This laboratory exercise was conducted with both non-majors and majors in several biological science classes. The non-majors did not participate in aquatic larval collection but found the exercise to be interesting. Non-majors were able to discuss additional variables such as the size and age of the larvae that might create differences in their observed results. Biology majors were taken into the field and collected the insect larvae that they needed for the experiment. Students really seemed to enjoy getting wet and dirty. They felt ownership for the experiment. For example, a biology major wrote "I think being involved and active from start to finish with this experiment helps students to see the whole scientific process. It holds our interest because it has real life applications."

INSTRUCTOR NOTES

Classroom resources: Most students will likely have little prior knowledge of aquatic insects and their larvae. It is suggested that instructors have insect examples (pinned specimens, insect in vials of alcohol, or live cultures) or pictures to provide students with guidance in identifying experimental organisms. A table of common aquatic insect larvae and tips for their identification is included in Appendix 1. For students with little previous experience with insects, allowing them to make predictions of non-target effects based on common names can lead to a discussion of scientific versus common names after the exercise. For example, the common name of "fly" applies to both black flies, which are Diptera, and caddis-flies, which are Trichoptera while the common name of the target organism, mosquito, which is a Diptera is not called a "fly".

Mosquito larvae: Mosquitoes can be ordered as either larvae or as egg rafts from Carolina Biological. Despite the added expense, ordering live larvae is recommended. Hatching of egg masses is not uniform and mosquito larvae need to grow for 2-3 weeks to be large enough for experiments. As an aside, if you use collected mosquito larvae, there is no likelihood of disease transmission. If surviving larvae are left to emerge, female mosquitoes will seek blood meals, and although unlikely, it is possible to transfer disease. Therefore, all larvae should be disposed of by being allowed to dry out or by being frozen.

Bti products*:* Bti bits and dunks can be obtained from most garden stores or from online vendors. It is important that the Bti be stored in a cool, dark area because it is photo-reactive and degrades quickly. Products that were stored properly for more than a year have been used successfully.

Preparation of Bti concentrations*:* To increase the ease of measurement for the students, stock solutions were made that could be added in 1 ml volumes. A stock solution of 100 mg ml^{-1} was made by adding 100 mg of bits or pulverized dunks to 1 ml of distilled water or tap water. The solution was vortexed for approximately 2 minutes to allow the Bti to solubilize. (There will be a lot of matrix debris in the stock solution that must be discarded.) From the stock solution, the 100 µg ml^{-1} solution can be made by diluting the stock 5x in water. To make the 10 $\mu g ml^{-1}$ solution we diluted the 100 µg ml^{-1} solution 10x. Finally to make the 1 $\mu g ml^{-1}$ solution, the 10 $\mu g ml^{-1}$ solution was diluted 10x.

ACKNOWLEDGEMENTS

We thank the department of Biology at UNK for its support and especially Charles Bicak for useful comments on an earlier version of this manuscript. This project was funded in part through a grant from the University of Nebraska at Kearney's Research Services Council.

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APPENDIX 1. Common aquatic insect larvae and how to identify them to order.

Order Diptera, Family Culicidae. Mosquito larvae. They are very active as larvae (giving them the common name, wiggler). They are distinguished by having large eyes, long hairs on their body, and no legs.

Order Diptera, Family Simulidae. Black fly larva. These fly larvae attach to the substrate. They are distinct from other insects because they have no visible legs and because the end that attaches to the substrate appears swollen.

Order Ephemeroptera. **Mayflies**. Most appear flattened. They are identified by having six visible legs and three long thin tails. They also have visible antennae. They are distinguished from larval damsel flies by having longer antennae and longer thinner tails.

Order Trichoptera. Caddisflies. These insects often make cases as larvae, which they carry around on their backs. They are identified by having six visible legs and a tuft of hairs on their posterior.

Order Diptera, Family Chironomidae. **Midges**. These insects are fly larvae that are sometimes called bloodworms because many of them are red in color due to the presence of hemoglobin. They are identified by the absence of legs and a characteristic head that resembles a wiener dog.

Order Odonata. Dragonflies. They have six visible legs and three shorted tails. They typically have short visible antennae. They have 3 plate-like tracheal gills at the caudal end of the body.

ACUBE 47TH Annual Meeting

October 9-11, 2003

Truman State University
Kirksville, MO

Biology for Contemporary Living

Preliminary Program

Thursday, October 9th

2:00 - 5:00 PM	**Pre-Conference Field Trip: Crinoid fossil quarry**	**Meet in Violette Hall foyer**
3:00 - 5:00 PM	**Steering Committee Meeting**	**Conference Room Student Union**
6:00 - 8:00 PM	**Registration and Reception** *Heavy hors d'oeuvres*	**Violette Hall**
8:00 - 9:00 PM	**Opening Session**	**Violette Hall**

Welcome to ACUBE:
ACUBE President: **Margaret Waterman**, *Southeast Missouri State University*

Welcome to Truman State University:
President, Truman State University: **Dr. Barbara Dixon**
Division of Science Chair: **Scott Ellis** *Truman State University*
Program Chair: **Lynn Gillie** *Elmira College*
Local Arrangements Chair: **Nancy Sanders**. *Truman State University*

OPENING ADDRESS (Public Welcome to Attend)

When the Exotic Becomes Invasive: Familiar Questions wit' Stwange Anthers

Dr. Michael Kelrick, Division of Science,
Truman State University

9:15 - 10:15 PM	**Steering Committee Meeting**	**Conference Room Student Union**

Friday, October 10th

7:00 AM - 5:00 PM	**Registration table** - Open all day. Please check your membership status; Inquire about audiovisual needs; General information	**(all locations are in the Student Union unless otherwise indicated)**
7:00 - 8:00 AM	**Buffet Breakfast** (by Interest Group)	**Georgian Room**
7:30 - 10:30 AM	**Field Trip: Birding**	**Meet outside Georgian Room**
9:00 AM - Noon and 2:00 - 5:00 PM	**SUSTAINING MEMBER EXHIBITS** Refreshments provided	**Activities Room**
8:15-9:45 AM	**CONCURRENT WORKSHOP SESSIONS I**	
	1. Easy Ways To Do Physiology Labs with Products from iWorx/CB Sciences**.** **Steve Andre,** iWorx/CB Sciences, Inc.	**Pickler Memorial Library Room 103**
	2. Investigative Activities and Cases from Microbes Count!. **Ethel Stanley and Margaret Waterman**, Beloit College and Southeast Missouri State University	**Pickler Memorial Library Room 203**
	3. The Non-target Effects of Bti Toxin on Aquatic Insects. **Julie J. Shaffer and William W. Hoback**, University of Nebraska at Kearney	**Student Union Room 309**
9:50-10:20 AM	**POSTER SESSION I** Refreshments provided	**Activities Room**
	1. Developing a Three-Tiered Test to Diagnose Misconceptions in College Biology Students. **Barbara Gaddis and Sandra Berry-Lowe**, CU-Colorado Springs	
	2. Improving Information Literacy for Biology Majors **Vaughn Gehle**, Southwest Minnesota State University	
	3. Using Baker's Yeast *Saccharomyces cerevisiae* as a Model for Molecular Genetics **Laura Salem**, Rockhurst University	
	4. The NASA Astrobiology Academy. **Morgan Perrone, Crystal Gammon, Anne Dekas, and Steve Mitchell,** NMSU, Washington University, Harvard, and U of Maryland-College Park	
	5. Student Projects in a Team-taught, Mixed-Major Field Course. **Lynn Gillie**, **Robert Erdman**, **and Todd Egan**, Elmira College	
	6. Investigations: An Animal Model of Diabetes. **John J. Rutter**, Truman State University	
	7. The Use of Service Learning to Meet Learning Objectives in General Biology Courses. **Lisa Felzien**, Rockhurst University	
	8. Plaque Assay and Nucleic Acid Analysis of Lytic Coliphages from Creek Water and Domestic Sewage. **Omokaro Obire and Michael Lockhart**, Rivers State University of Science and Technology, Port Harcourt, Nigeria and Truman State University, Kirksville	

10:30 - 11:15 AM	**CONCURRENT PAPER SESSIONS I**	**Student Union**
	1. Limitations of Simulations: Objectives Met Only With Genuine Labwork, With a Focus on Animal Dissection. **John Richard Schrock**, Emporia State University	**Room 307**
	2. Seeing Plants as Doing Plants: How to Teach Students to See Plants by Using Taxonomy. **Suzanne Martin,** Moberly Area Community College	**Room 308**
	3. Microbial Ecology Activities from *Microbes Count!*. **Ethel Stanley**, Beloit College	**Room 309**
	4. The Undergraduate Research Program at Truman State University. **Jeffrey M. Osborn**, Truman State University	**Governor's Room 310**
11:20 - 12:05 AM	**CONCURRENT PAPER SESSIONS II**	**Student Union**
	1. Gardens as Classrooms: Using Gardens for Teaching and Research. **Steve Carroll,** Truman State University	**Room 307**
	2. Integrating the Scientific Method into Anatomy and Physiology Laboratories. **Karyn Turla**, Friends University	**Room 308**
	3. A Web-based Resource for the Teaching of Evolutionary Biology as an Applied and Investigative Laboratory Science. **Joanna Vondrasek, Janis Antonovics, and Doug Taylor,** University of Virginia	**Room 309**
	4. Teaching Biology Courses in the Face of Poverty and Ignorance. **Omokaro Obire**, Rivers State University, Nigeria, and Truman State University	**Room 310, Governor's Room**
12:15 - 1:00 PM	**Luncheon and First Business Meeting**	**Georgian Room**
	First and Final Call for Nominations!!	
	Out of this World Teaching Idea contributions	
1:00 - 1:45 PM	**LUNCHEON PROGRAM**	**Georgian Room**
	The Challenges Ahead in Educating 21st Century Biologists. Dr. Judith Dilts, Dr. Burnell Landers Chair of Biology and Professor, William Jewell College	
2:00 - 5:00 PM	**Field Trip: Restored Prairie**	**Meet outside Georgian Room**
2:00–2:45 PM	**CONCURRENT PAPER SESSIONS III**	**Student Union**
	1. Can a New Dog Learn Old Tricks?: A Junior Faculty Member puts NSF's Recommendations for Science, Math, Engineering, and Technology (SME&T) Education to Task. **Peter White,** Colby-Sawyer College	**Room 309**
	2. Development of a Research-Based Course for Undergraduates in RNA, DNA, and Protein Extraction, Purification, and Characterization. **Tom Tauer** Coe College	**Room 308**

	3. Unclassifying Classical Physiology Laboratories. **Gregory Grabowski,** University of Detroit Mercy	**Room 307**
	4. Introducing Epidemiology in Microbiology Labs Using a Model of a Smallpox Epidemic Started by a Bioterrorist. **Alicia Wilson**, AKL Informatics	**Governor's Room 310**
2:50 - 3:20 PM	**POSTER SESSION II** Refreshments provided Posters from the morning session still available for review	**Activities Room**
3:30 - 5:00 PM	**CONCURRENT WORKSHOP SESSIONS II**	
	1. IOptimize Integrated Learning System (utilizing the power of onsite-online interface in Teaching and Learning). **Abour Cherif, Stefanos Gialamas and Lin Stefurak**, DeVry University	**Student Union Room 309**
	2. An Introduction to Working with Nucleic Acid and Protein Databases. **Brent Buckner and Diane Janick-Buckner**, Truman State University	**Pickler Memorial Library Room 103**
	3. AMCBT's/ACUBE's Golden Anniversary Ideas! Memories! Accomplishments!. **Margaret Waterman,** Southeast Missouri State University	**Student Union Governor's Room 310**
5:05 - 5:45 PM	**Web Committee Meeting**	**Conference Room**
6:00 - 7:00 PM	**Social** Still National Osteopathic Museum and historic medicinal garden (resumes of candidates available for review)	**Tinning Education Center, Kirksville College of Osteopathic Medicine (KCOM)**
7:00 - 9:00 PM	**NE Missouri Dinner and Second Business Meeting** (two-minute speeches prior to dinner; balloting after)	**The Commons, KCOM**
	DINNER PRESENTATION **Kirksville's Harry Laughlin (1880-1943): Applying Classroom Genetics for the 'Betterment' of Humanity. Dr. Philip Wilson**, Penn State College of Medicine *Presentation of the 2003 Out of this World Teaching Idea*	**McCreight Auditorium, KCOM**

Saturday, October 11th

7:30 - 8:45 AM	**Buffet Breakfast** (by Interest Group)	**Georgian Room Student Union**
7:45 - 8:45 AM	**Bioscene Editorial Board**	**Georgian Room**

9:00 - 9:45 AM	**CONCURRENT PAPER SESSIONS IV**	**Student Union**
	1. Bioscience by Design. **Bob Aron, Bashar Hanna, and Abour Cherif,** DeVry University	**Room 309**
	2. Biological Andragogy. **Marya Czech,** Lourdes College	**Room 308**
	3. Shut up and Let the Students Learn: A Flexible No-Lecture Teaching Strategy that Deepens Student Understanding. **Neil Sabine**, Indiana University East	**Room 310 Governor's Room**
	4. NASA Ames Astrobiology Academy 2003: Astrobiology at Deep Sea Vents. **Morgan Perrone, Crystal Gammon, Anne Dekas, and Steve Mitchell,** NMSU, Washington University, Harvard, and U of Maryland-College Park	**Room 307**
10:00 - 10:45 AM	**CONCURRENT PAPER SESSIONS V**	**Student Union**
	1. iBench: Instruction in Basic Equipment Needed for Chemistry and Biology. **Tom Tauer** Coe College	**Room 309**
	2. Utilizing Technology to Link Alums with Undergraduate Learning. **Austin Brooks,** Wabash College	**Room 308**
	3. Shut Up and Let the Student Learn: Changes in Student Perceptions and Performance in an Active Learning Environment. **Neil Sabine**, Indiana University East	**Room 310 Governor's Room**
	4. Hierarchy Theory: An Underutilized Helpmate for Understanding Complex Concepts in Undergraduate Biology Courses. **Jon Gering,** Truman State University	**Room 307**
11:00 AM - 12:15 PM	**Luncheon and Third Business Meeting**	**Georgian Room**

BUSINESS MEETING

Resolutions:
Dick Wilson, Rockhurst University
Executive Secretary Report:
Pres Martin, Hamline University
Bioscene:
Ethel Stanley, Beloit College & Tim Mulkey, Indiana State University
Presidential Address:
Margaret Waterman, Southeast Missouri State University
2004 Meeting:
Austin Brooks, Wabash College

12:30 - 3:00 PM	**Steering Committee Meeting** Includes newly elected Steering Committee members!	**Conference Room**
12:30 – 4:00 PM	**Post conference Field Trip** Open-air flea market, game birds and the Mennonite store	**Meet outside Georgian Room**

ABSTRACTS of PRESENTATIONS

Concurrent Workshop Sessions I
8:15-9:45 am
Friday, October 10, 2003

Easy Ways to do Physiology Labs with Products from iWorx/CB Sciences. ***Steve Andre**, iWorx/CB Sciences*

Physiology teaching kits and Labs on CD/Labs on Line from iWorx/CB Sciences make it easy to do human and animal physiology experiments includes cardiovascular, neuromuscular, and respiration exercises. Teaching kits include all the hardware (except computer), software, and courseware needed to do over 45 experiments and multiple exercises. Data collection and analysis can easily be accomplished with the "click" of a button or two. Users can also complete experiments of their own design with the same "click and play" ease.

The same types of experiments can be done without the need for any hardware, besides a computer, in lab with Labs on CD or over the Internet with Labs on Line. With Labs on CD/Labs on Line products from iWorx, students record and analyze data just as they would with a physiology teaching kit. Animations, illustrations, and digital movies compliment each lab exercise in Labs on CD/Labs on Line.

Participants in this workshop will be able to collect and analyze data with Labs on CD/Labs on Line and do the same with iWorx physiology teaching kits.

Investigative Activities and Cases from *Microbes Count*! ***Ethel Stanley** and **Margaret Waterman**, Beloit College and Southeast Missouri State University*

Interactively investigate new activities from *Microbes Count!* (2003). In the first two activities, we will use online bioinformatics tools to track the source of the West Nile virus in the 1999 New York outbreak and explore evolution using HIV patient data. The investigative case - *The Farmer and the Gene* - will also be introduced. All materials will be made available to participants.

The Non-target Effects of Bti Toxin on Aquatic Insects. ***Julie J. Shaffer** and **William W. Hoback**, University of Nebraska at Kearney*

The use of chemical insecticides to manage problem insect species has resulted in the mortality of non-targeted species including vertebrates creating unexpected ecological problems. Recent advances in molecular biology have allowed for the development of natural insecticides. One such insecticide designed to control mosquito larvae is a toxin from the bacterium *Bacillus thuringiensis israelensis* (Bti). Bti toxin exhibits specific activity against dipteran larvae. This toxin can be purchased commercially and used in the classroom to demonstrate the concept of non-target killing. In this laboratory exercise, students test the sensitivity of various aquatic insect larvae to the effects of Bti toxin. Students compare survivorship of mosquito larvae and other aquatic insect larvae to several concentrations of Bti toxin to determine lethal concentration and non-target killing. This exercise is appropriate for classes such as general biology, environmental biology, and microbiology. It teaches students about the use of natural insecticides and is safe and inexpensive.

Poster Session I
9:50-10:20 AM
Friday, October 10, 2003

Developing a Three-Tiered Test to Diagnose Misconceptions in College Biology Students. ***Barbara Gaddis** and **Sandra Berry-Lowe**, CU-Colorado Springs*

Even after successfully completing science courses, many college students exit the classroom with the same misconceptions with which they entered. Exposure to correct scientific principles generally decreases misconceptions, but does not eliminate them, as misconceptions continue to be held by college seniors, graduate students, community college professors, and pre-service teachers. Based on review of the literature and surveys of college biology faculty, the authors developed a computer-based three-tiered diagnostic test to assess misconceptions. The development of this test, the assessment of misconceptions through clicker interactive technology, and preliminary research results will be described. This project was supported by NSF.

Improving Information Literacy for Biology Majors. ***Vaughn Gehle**, Southwest Minnesota State University*

The biology major at Southwest Minnesota State University requires a capstone presentation on any aspect of biology. To eliminate the too frequent "Disease of the Week" and "Why I like Biology" presentations, we instituted a requirement that students locate and integrate at least two peer-reviewed research papers into their presentations. This led to the discovery that our students were information illiterate: they could not locate research papers and didn't know what to do with the papers once found. Our remedy was a revamping of our curriculum to include two seminar courses and more extensive writing of lab reports. The first seminar course is targeted at sophomores and teaches how to find and access scientific databases, how to distinguish between news, review, and research articles, and how to read research articles. Lab courses that students would typically take between sophomore senior years reinforce those learned skills by requiring students to write numerous lab reports that incorporate supporting literature citations. The final seminar course, populated by seniors, teams each student with a faculty mentor who helps the student narrow their topic, critically evaluate the published literature, and prepare a poster presentation. The presentations are given to all faculty and students enrolled in both seminar courses. Our current method of assessing the quality of these presentations will be discussed. These curricular changes, instituted three years ago, appear to have improved the information literacy of our students.

Using Baker's Yeast *Saccharomyces cerevisiae* as a Model for Molecular Genetics. ***Laura Salem**, Rockhurst University*

Saccharomyces cerevisiae (Baker's yeast) is an ideal eukaryotic organism for biological studies. The power of yeast genetics has become legendary and is the envy of those who work with higher eukaryotes. The complete sequence of its genome has provided important tools for bioinformatics. Although yeasts have greater genetic complexity than bacteria, they share many of the technical advantages of molecular genetics of prokaryotes. This poster will present experimental advantages and techniques involving the use of *Saccharomyces* in the laboratory. Experiments utilizing genetic, molecular, and biochemical approaches will be addressed.

The NASA Astrobiology Academy. ***Morgan Perrone, Crystal Gammon, Anne Dekas,*** *and* ***Steve Mitchell****, NMSU, Washington University, Harvard, and U of Maryland-College Park*

The NASA Astrobiology Academy is a unique summer institute of higher learning whose goal is to help guide future leaders of the U.S. Space Program. It provides research opportunities in state-of-the-art Astrobiology laboratories coupled with broad-based views into the inner workings of the space program. The Academy is an intense summer experience with little free time. A significant portion of the student's time will be spent as a group or a team working on projects, listening to and debating lectures, and traveling together. These avenues help to develop the leadership, teamwork, and critical thinking skills that are important to our nation's future in space. In addition to the rich intellectual environment, students will be assigned to a Principal Investigator to work independently on a technical project. The mentor relationship that evolves gives the RA's insight into the trials and rewards of primary scientific research. The Academy students also tour each NASA center in California as well as local space industries and academic programs. Overall, the Academy provides the students with an unhindered view into the space program.

Student Projects in a Team-taught, Mixed-Major Field Course. ***Lynn Gillie****,* ***Robert Erdman****, and* ***Todd Egan****, Elmira College*

A travel/field course in Marine and Island Ecology can be used to introduce science majors and non-science majors to biological diversity and ecological field methods. Mini-projects in botany and zoology have been useful tools in guiding and assessing student learning. Students are grouped according to experience, with no more than one science major per group. Some examples of projects completed include analysis of vegetation profiles in different habitats, kite diagrams of intertidal community diversity, and construction of behavioral time budgets. Students design the project, then meet with the instructors for revisions to the proposal. After data collection and analysis, students present results to their peers. The success of a mixed majors/non-majors course that uses projects will be discussed.

Investigations: An Animal Model of Diabetes. ***John J. Rutter****, Truman State University*

An understanding of the pathophysiological conditions that arise as a result of disease states provides valuable insight into the processes that serve to maintain homeostasis. As a supplement to lecture inclusion of such material, we have developed an investigative laboratory exercise that centers around an animal model of diabetes. Briefly, a hyperglycemic (high blood sugar) condition can be induced in rats via a single injection of streptozotocin. This compound selectively destroys the ß-islet cells in the pancreas that produce insulin; as such, this treatment produces symptoms that arise in Type 1 diabetes in humans. In spite of the metabolic imbalances that arise as a consequence of this disease state, the animals can be kept viable for a period of several weeks following administration of the toxin, enabling students to measure a variety of end points reflective of the early stages of diabetes.

The Use of Service Learning to Meet Learning Objectives in General Biology Courses. ***Lisa Felzien****, Rockhurst University*

Service learning involves working with students to provide service to the community that requires students to meet learning goals related to coursework. The three major components of effective service learning experiences are developing clear learning objectives, completing a meaningful project in the community, and reflecting on what was learned from the project. Service learning was used in a general biology course to show students the importance of promoting scientific education within the community and to help students learn about challenging course topics by having them teach others about those topics. Students were required to develop learning objectives, design and complete a community service exercise, and write reflection papers to assess their learning and development. Undergraduate students worked with community students of either grade school or high school ages, providing learning experiences relating to the topic of photosynthesis. Undergraduates worked in groups of four, and collaborations between groups were required to complete the projects. Information gathered through reflection papers showed high student satisfaction in the areas of contributing to the learning of others, of contributing to their own learning, and of supporting the mission of the university.

Plaque Assay and Nucleic Acid Analysis of Lytic Coliphages from Creek Water and Domestic Sewage. ***Omokaro Obire*** *and* ***Michael Lockhart****, Rivers State University of Science and Technology, Port Harcourt, Nigeria and Truman State University, Kirksville*

Assessment of water quality in agricultural and industrial waterways generally focuses on chemical and bacteriological indicators. Many pathogenic bacteria harbor phages (bacterial viruses) which establish a symbiotic relationship in the host known as lysogeny. In contrast, the lytic phages infect and destroy the host bacterium by producing a high number of viral progeny and lysing the host cells similar to that of viral infections of plants and animals. The occurrence of lytic phages in coliform bacteria is predicted to shorted their lifespan and reduce their numbers in the environment and act as a natural biological control. In this study, we assessed the presence and concentration of lytic viruses of *Escherichia coli* and *Enterococcus faecalis* in Bear Creek (Missouri) and domestic sewage in a rural lagoon (near Kirksville, MO). We used the plaque assay method to quantify the number of phages in water samples. Phage DNA was isolated and the relative sizes, in base pairs, of phage genomes were analyzed by gel electrophoresis. A characterization of the lytic phages of coliform bacteria isolated from creeks and sewage should lead to identification of phages which could be used in the biological control of pathogenic bacteria which frequently contaminate agricultural water sources. This work was supported by Truman State University, Kirksville, MO, USA and Rivers State University of Science and Technology, Port Harcourt, Nigeria.

Concurrent Paper Sessions I
10:30-11:15 AM
Friday, October 10, 2003

Limitations of Simulations: Objectives Met Only With Genuine Labwork, With a Focus on Animal Dissection. ***John Richard Schrock****, Emporia State University*

The main arguments made by the animal rights and computer community against animal labwork are summarized. Objectives not met by simulations are detailed and include: A)experience base to make concepts "meaningful," B)genuine interactivity, C)use of the sense of touch or "palpation," D)learning how to observe, E)understanding abnormality and imperfection in anatomy and development, F)test truthfulness, G)open ended experiments beyond those programmed into a simulation, H)confirmation that science results are genuine and universal, I)real consequences that command the students' attention and generate excitement, J)greater "respect" for complex internal anatomy as soft, wet machinery, K)normalization of students' attitude to blood, feces, etc., L)recruitment into the medical or academic profession, and M)the economics of reality-based labs over most computer simulations.

Seeing Plants as Doing Plants: How to Teach Students to See Plants by Using Taxonomy. ***Suzanne L. Martin****, Moberly Area Community College*

Using the example of plant taxonomy, this paper shows how learning science in a deep way can take place by non-science majors in the lower tiers of the college population by embodying assumptions about the subjective, experiential, evaluative, communicative, communal nature of science in the action of learners. As Heinz von Foerster stated, students who wish to learn to *see* plants must learn how to *act*. Students don't see what the instructor sees--no matter how botanical terms are described or illustrated. The students don't "get the point" until they have a framework of experience. In the context of field and lab activities, introductory botany students experience seeing as a result of a process of interaction with plants. In order to act, they learn through experience and through conversation that plant morphology terms are created for convenience in identifying plants and that the terms are constructs rather than intrinsic properties of plants—that the plants "don't read the text." The students gain an insight into science as a way of seeing and as a system for communication rather than a collection of facts. In the process, how they see and interact with the world changes.

Microbial Ecology Activities from *Microbes Count!* *Ethel Stanley*, *Beloit College*

Learn more about new models and simulation activities from *Microbes Count!* (2003). In this session, several activities featuring microbial ecology will be introduced. This includes demos of wine fermentation, control of a resistant mold, microbial growth in Biosphere 2, and development of hypoxia zones. (Windows and Mac compatible)

Concurrent Paper Sessions II
11:20-12:05 AM
Friday, October 10, 2003

Gardens as Classrooms: Using Gardens for Teaching and Research. ***Steve Carroll****, Truman State University*

High-quality natural areas are not always conveniently located or easily accessible during the one to three hours typically available for labs. One solution to this predicament is to teach all labs indoors, but another is to use existing gardens, or to plant new gardens, in order to create your own study sites. I will describe how my students and I have used a variety of gardens for teaching and research. These gardens have included (1) a planting of alternative crops (e.g., sesame, amaranth) at the Truman State University farm that is used by students in Ecology, Economic Botany, and other classes; (2) a small prairie garden that has been used by students conducting independent research on pollination; (3) a prairie planting on public school property that will serve as the site of a prairie festival for the city's second-grade classes; and (4) a 19^{th} century medicinal garden that was designed and planted as an independent research project by a Truman student who has since gone on to graduate school in landscape design. This last garden will be the site of the Friday evening social. I will show slides of these and other gardens and will encourage discussion of how we can improve our teaching and research by using gardens that are already in place; gardens that we may choose to install; or gardens that students can help design and plant.

Integrating the Scientific Method into Anatomy and Physiology Laboratories. ***Karyn Turla****, Friends University*

Many students learn the scientific method through prescribed labs where the experimental setup is described for them, the reagents they will need to use are listed, and the actual experimental design is laid out for them step by step. The students can get an idea of what the scientific method is, but do not obtain a full appreciation for the complexities of the scientific method by using this approach. I have developed a lab in my Anatomy and Physiology course that to my surprise was challenging and very educational for the students. The lab exercise is designed to get the students to test parameters that affect the rate of diffusion and osmosis; a subject that is relatively simple for these junior level students. However, in this lab the students receive only a list of equipment and reagents available to them. They are required to develop four experiments; two to test factors affecting diffusion and two to test factors affecting osmosis. For each experiment, they are to define the variables, describe their experimental setup, collect data and discuss their results in a lab report that mimics the format of a research paper. The students seem to struggle with the lab, many stating that they have never had to design an experiment before. Many students begin to appreciate the importance of defining all the controlled variables when they conduct an experiment without an important variable controlled. I have found that once the students have gone through this lab, they have a better understanding of the scientific method, and how to conduct an appropriately controlled experiment.

A Web-Based Resource for the Teaching of Evolutionary Biology as an Applied and Investigative Laboratory Science. ***Joanna R. Vondrasek*, *Janis Antonovics*,** *and* ***Doug Taylor****, University of Virginia*

Recently, evolutionary biology has developed into a vibrant, investigative science with great relevance to societal issues. The teaching of evolutionary biology, however, is still largely taught as a theoretical, dialectical discipline. Rarely is it taught as an experimental, analytical science of applied relevance on par with physiology or molecular biology. As part of an NSF Curriculum Development Grant, we have created a website intended to be a resource for instructors of undergraduate evolutionary biology classes. The website includes a complete sample syllabus of laboratory and recitation exercises designed to actively engage students in the practice of evolutionary biology. In addition, we have collected and listed numerous evolution-based laboratory and field exercises from other sources. Examples of the resources available on the website will be presented.

Teaching Biology Courses in the Face of Poverty and Ignorance. ***Omokaro Obire****, Rivers State University, Nigeria and Truman State University, USA.*

I teach courses in virology and environmental microbiology to undergraduate and graduate students at Rivers State University in Port Harcourt, Nigeria. The typical biology course provides four hours of lecture and one laboratory period each week. The bi-semester system is modeled after the American System. In many developing countries the policy makers are opportunists and barely literate. The education of children and college students is low on the list of priorities. The most basic educational aids such as books and facilities are generally of low quality and in many cases lacking. The college preparedness among students is highly varied and many of the successful ones have 'cheated' to gain admission to university. I will share my own experiences and some creative ways we manage to teach science courses with limited funding, limited facilities, unreliable utilities, student unrest, and political instability.

Concurrent Paper Sessions III
2:00-2:45 PM
Friday, October 10, 2003

Can a New Dog Learn Old Tricks?: A Junior Faculty Member puts NSF's Recommendations for Science, Math, Engineering, and Technology (SME&T) Education to Task. ***Peter White****, Colby-Sawyer College*

In a 1996 report, *Shaping the Future: New Expectations for Undergraduate Education in SME&T*, the National Science Foundation assembled several specific recommendations for curricular and pedagogical improvement in SME&T disciplines. These recommendations included (italics added) 1) incorporating *new knowledge* into lower level courses more rapidly and more thoroughly, 2) introducing SME&T concepts by examining *current issues* for which students have a personal context, 3) organizing courses (or course modules) to address *real world problems*, and 4) developing curricula that expose students to key *interdisciplinary connections* stressing concepts as much as facts. Just as these recommendations parallel the theme of ACUBE's 47th Annual Meeting, they also constituted the framework for two seemingly unrelated courses taught by the presenter in the past year; Process of Discovery, a required course for all students with high freshman and sophomore enrollment, and Cellular Pathophysiology, an upper-level elective for biology majors. For both courses, classical case-based learning was used to introduce and explore current issues and concepts. The successes and limitations of this approach will be the main focus of the session. Curriculum design, specific examples of course content, and qualitative and quantitative student feedback will also be discussed.

Development of a Research-Based Course for Undergraduates in RNA, DNA, and Protein Extraction, Purification, and Characterization. ***Tom Tauer****, Coe College*

Undergraduates are enrolling in courses that discuss molecular biology at a greater depth than ever before. It is imperative that these students are provided the opportunity to conduct research using the molecular biology they have studied. Some undergraduate courses expose the students to various molecular biology techniques, but are 'canned' exercises that do not reflect the true inquiry-based learning/hypothesis-driven experimentation that research encompasses. I have developed a course that incorporates the extraction, purification, and characterization of RNA, DNA, and protein for undergraduates. The course incorporates biology, physics, chemistry, statistics, and computer concepts, in addition to introductory bioinformatics. I will discuss the course curriculum, expenses, and outcomes.

Unclassifying Classical Physiology Laboratories. ***Gregory M. Grabowski****,* ***Travis McGrady*****,* ***Megha Patel*****,* ***Inna Shcherbinina*****, and* ***Anthony Smykla*****, University of Detroit Mercy; *Undergraduate research assistants*

As physiology lectures become more focused on the cellular basis of homeostasis, physiology laboratory manuals remain steeped in classical laboratories that focus on decades old concepts of organ-based homeostasis. The challenges of a cellular based physiology laboratory include time limitations, expense, and specialized equipment. These challenges are especially difficult to overcome when investigating the physiologic role of second messenger systems, however these can be met using a colormetric assay for determining phosphate concentrations in 1.5 ml centrifugation tubes and a spectrometer set at 750 nm. Using phosphotyrosine as a substrate, homogenate from organs (rat liver, heart, muscle, lung, and kidney) or various *Xenopus* tadpole stages can be assayed for phosphotyrosine phosphatase activity within a three hour laboratory session. Phosphate freed from phosphotyrosine is precipitated with molybdate to form a color complex. Absorbencies are contrasted with known phosphate standards, which are standardized to the protein concentration of each sample. Assays are also run in the presence and absence of metavanadate (phosphotyrosine phosphatase inhibitor). Students learn to standardize data and utilize controls for determining second messenger activity under various physiologic states, and the professor avoids using expensive materials and equipment, as well as avoiding safety problems associated with using phosphate isotopes. (Funded by FGIP #425)

Introducing Epidemiology in Microbiology Labs Using a Model of a Smallpox Epidemic Started by a Bioterrorist. ***Alicia Wilson****, AKL Informatics*

Bioterrorism has become an increasing concern and is of particular interest to nursing students. A Stella model of a smallpox epidemic has been developed with an instructional interface for students taking nursing microbiology. In the case presented in this model, a terrorist enters a community with 200,000 people who may be unvaccinated, vaccinated recently or vaccinated many years ago. By "turning" knobs in the interface on the computer screen, students can explore the effects of varying the vaccination status of these people. Some serious risks of vaccination are discussed. In addition, there are 2000 people in the community who have severely impaired immune systems and should not be vaccinated with the live vaccine used for protection against smallpox. The effects of the vaccination status of the rest of the community on the smallpox mortality in the immune suppressed group provides a dramatic demonstration of herd immunity. The effects of efficient isolation (or quarantine) are also explored. This lab exercise provides some basic introduction to epidemiology, especially the idea of the SIR model. Actual literature values were used to create the model when they were available, although smallpox was eradicated before AIDS, modern chemotherapy for cancer patients, kidney dialysis and organ transplantation created a substantial group of people with seriously impaired immune systems. Although the focus of the lab is biomedical, social and ethical issues can be considered during class discussion. In addition, the 30% mortality rate for unvaccinated people with smallpox makes the lab results memorable.

Concurrent Workshop Sessions II
3:30-5:00 PM
Friday, October 10, 2003

IOptimize Integrated Learning System (utilizing the power of onsite-online interface in Teaching and Learning). ***Abour H. Cherif, Stefanos Gialamas*** *and* ***Lin Stefurak****, DeVry University*

In this presentation we will present DeVry University's Model of iOptimize Integrated Learning System utilizing the power of onsite-online interface. In addition we will present the necessary elements for designing, and implementing this Integrated Learning System. Finally we will share our experience on re-designing more than 300 courses, training more than 1600 faculty and academic administrators, preparing more than 11,000 students, and adopting technology that is reliable and powerful enough to implement the DILS. The DILS was developed based on the review of related literature, action research within DeVry University, the continuing assessment of the effectiveness of various teaching and learning strategies, and the continuing assessment of the effectiveness of the Integrated Learning System within DeVry University. We will explain how we use the knowledge and information from all these sources to develop the iOptimize Integrated Learning System.

For example, the related literature indicates the following categories of modes of educational delivery: (1) Face to face delivery mode of learning; (2) Face to face with Internet access delivery mode of learning; (3) Online delivery mode of learning; (4) Closed circuit system mode of delivery of learning. (5) Hybrid delivery mode of learning; (6) Independent project mode of learning; (7) TV/Textbook independent delivery mode of learning; (8)Team Work Independent Project. The iOptimize Integrated learning System comes under the Hybrid Delivery Mode of Learning.

The literature review also indicated that "Hybrid", "Blended", and "Optimize" are three most frequently used terms in literature for teaching learning materials using more than one mode of delivery. However, there is no consistency in literature on the meaning for and the use of each of these terms. For example, a literature review has indicated that the meaning of "Hybrid Course" has several interpretations to different professionals based on the goals and the objectives in the minds of those who used the term in their research studies and/or educational institutions. Furthermore, literature review also indicated that there are Institutional Initiatives as well as Individual Faculty Initiatives to design and implement one type of another of the hybrid mode of delivery.

In summary we will present a model of instruction that integrates onsite and online modalities in supporting the various components of teaching and learning. We believe this model corresponds to the emerging dominant reality of the workplace, which combines onsite and online modes of interaction directed at the accomplishment of organizational objectives. Moreover, we believe this model will optometry support student learning, by combining once a week onsite classes with support of faculty and fellow students through online interaction throughout the week.

To accomplish implementation goal of the Integrated Learning Experience in DeVry University a user-friendly common course management system for all online and onsite courses has been designed, developed and implemented. Key to the effective implementation of this Paradigm is the preparation, training and development of faculty and their academic leaders. In addition, preparing students to understand, and accept the DeVry University Integrated Learning Experiences is a necessary condition for the success of this University-wide initiative. The cornerstone of the course conversions, and faculty training and support, is the delineation of the relative and complementary strengths of the onsite and online modalities as applied to the components of the teaching and learning process.

An Introduction to Working with Nucleic Acid and Protein Databases. ***Brent Buckner*** *and* ***Diane Janick-Buckner****, Division of Science, Truman State University*

An ever increasing number of organisms' genomes have been completely sequenced. These genomic sequences are incredible resources of data and information which can be utilized in the primary research and educational efforts of nearly all of the contemporary subdisciplines of biology. It seems essential that scientists, educators and students, especially biology majors, be able to access, manipulate and understand the sequence information available in gene and protein databases. Participants of this workshop will learn the basics of navigating and searching select databases at the National Center for Biotechnology Information (NCBI). Participants will learn how to search for, and retrieve, a sequence of interest (i.e., a query sequence) using Entrez (a retrieval system for searching databases) and to perform a variety of BLAST (Basic Local Alignment Search Tool) searches including: nucleotide-nucleotide BLAST searches (blastn), pairwise nucleotide BLAST searches and translated BLAST searches (blastx uses a nucleotide query to search the protein database and tblastx uses a nucleotide query to search the translated nucleotide database). Emphasis will be placed on concise explanations of how these programs work and on how the data outputs are interpreted. The workshop leaders will then assist the participants in performing the same type of searches with a query sequence of the participants' choosing. Lastly, time will be spent helping participants plan integration of these skills into their existing curriculum.

AMCBT's/ACUBE's Golden Anniversary Ideas! Memories! Accomplishments! ***Margaret Waterman,*** *Southeast Missouri State University*

ACUBE will soon be celebrating its fiftieth anniversary as an organization dedicated to excellence in college biology teaching. In this session, you are invited to brainstorm and help shape this major event. In what ways can the spirit of ACUBE (formerly known as the Association of Midwest College Biology Teachers) be represented? What kinds of memorabilia exist? What speakers, exhibits, stories, presentations, and themes might be appropriate? How can we publicize this important meeting to bring ACUBE more public attention? A panel of four ACUBE members, some newer, some of long standing, will be present to share their perspectives on the organization and to facilitate the brainstorming.

Concurrent Paper Sessions IV
9:00-9:45 AM
Saturday, October 11, 2003

Bioscience by Design. ***Bob Aron**, **Bashar Hanna**, and **Abour H. Cherif**, DeVry University*

The purpose of this presentation is to describe the instructional technology which DeVry University is using for its new bioscience curriculum. The healthcare and biotechnology industries are demanding specialized engineering technologists and informaticists. DeVry has programmatic strength in engineering technology and information technology. Recently, DeVry acquired the Ross University medical and veterinary schools, recognizing the growth in demand for medical professionals. Healthcare, medicine and medical technology is a new biomedical concentration for DeVry. Courses in the biosciences are core to all the DeVry biomedical programs. DeVry uses a learning model that emphasizes problem solving and application, not at the expense of theory, but ensures that graduates are immediately employable, as well as equipped for advancement in their careers. This application orientated approach extends to the course and lab design from two perspectives: (1) learning has objectives with applied outcomes; (2) labs and learning activities are highly integrated into the curriculum. This instructional design approach affords highly efficient instructional methods without compromising quality or safety. Examples of DeVry's new Chemistry and Biology course will be introduced.

Biological Andragogy. ***Marya Czech**, Lourdes College*

With the steadily increasing number of nontraditional age (25+ years) students in the ranks of undergraduates comes the task of meeting the diverse learning needs of yet another population. Adult learners are highly motivated, serious about their studies, but often lack solid study skills and are too far removed from their secondary school background to bring a significant repertoire of fundamental knowledge to their biology courses. After sharing descriptive studies and strategies, the presenter would like to engage other educators in conversation about the andragogical needs of science learners:

How are frameworks like Gardner's "Multiple Intelligences" applicable to the science learning of adults? How can a "constructivist" framework be effectively implemented with adult learners? Can textbooks change shape and size? Can publishers decrease the size of texts and increase the depth of learning? Can ancillaries be developed with attention to the needs of adult learners?

Shut Up and Let the Students Learn: A Flexible No-Lecture Teaching Strategy that Deepens Student Understanding. ***Neil Sabine**, Indiana University East*

A set of active learning strategies that place the responsibility for mastering course content mostly on students will be presented. The principal components of instruction are directed readings, group discussion, question-answer sessions, and daily evaluations. Formal student-teacher interactions are limited to question-answer sessions where the instructor only answers questions posed by the students. Students are evaluated over the material they were responsible for immediately after the instructor interview ends. The presentation will focus on presenting: 1) a mini-model of the learning environment, 2) the important components and flexible nature of the classroom format. Faculty generally preferred this learning environment to lecturing but their effectiveness was related to the amount of overall teaching experience they had and the amount of teaching experience they had in this learning environment.

NASA Ames Astrobiology Academy 2003: Astrobiology at Deep Sea Vents. ***Morgan Perrone, Crystal Gammon, Anne Dekas,** and **Steve Mitchell**, NMSU, Washington University, Harvard, and U of Maryland-College Park*

An apparatus comprised of multiple metal and tile plates with varying compositions was designed and assembled to be sent to a deep sea hydrothermal vent aboard the Russian MIR deep sea submersible. The apparatus spent two days on the ocean floor in the Snake Pit area (along the Mid-Atlantic rift zone near the Azores) accumulating biological material and corroding. After a retrieval dive, the apparatus was returned to the surface and preserved for analysis at Ames. Analyses used to identify and characterize microbial corrosion included diamidophenylindole (DAPI) DNA staining, energy dispersive X-ray spectrometry (EDS), and scanning electron microscopy (SEM). Results were uncertain, as DNA staining offered evidence of widespread microbial colonization. SEM and EDS did not confirm the presence of life on the metal surface. The project also featured a substantial outreach program, made available on various Space Grant websites. This program focused on grades 5-9 and the Girl Scouts. For teachers and students, lesson plans involving the group project and astrobiology in general were created. In addition, an Astrobiology badge program was created for Girl Scouts. Overall, the experiment and outreach has provided an excellent learning experience for the Academy students.

Concurrent Paper Sessions V
10:00-10:45 AM
Saturday, October 11, 2003

iBench: Instruction in Basic Equipment Needed for Chemistry and Biology. ***Tom Tauer**, Coe College*

Introductory biology and chemistry students typically have little experience with the equipment they will be using in the college laboratory. A pre-lab instructional activity that actively engages students will allow students to make more effective use of scheduled time in the lab. Properly designed computer modules are an ideal method for learning about and "virtually practicing" with new equipment. Unfortunately, current computer-based instructional activities in this area fail to intellectually engage students. We are developing a suite of online modules, named iBench, which will introduce students to relevant concepts and equipment before entering the introductory biology/chemistry laboratory. These modules are designed to be intellectually, as well as physically, interactive and allow students to "virtually practice" with each piece of laboratory equipment. I will demonstrate and discuss our progress with iBench.

Utilizing Technology to Link Alums with Undergraduate Learning. ***Austin Brooks**, Wabash College*

In recent years technology has provided instructors with a new arsenal of teaching strategies. For the biology teacher these include lectures that are not only extremely well illustrated but often include animations, movie clips and vicarious visits to biologically interesting locales via the World Wide Web. Laboratories as well have been impacted by new technologies. Data sharing between lab teams is now very easy, as a result of campus networks. Document cameras allow lab instructors to demonstrate delicate dissections as well as common laboratory techniques. Digital photomicrography can provide students with an accurate record of their laboratory observations. Simulations and case studies likewise are enhancing learning for our students. On-line discussion boards are, for some students, yet another way to become involved with a particular class. For the past several years I have been using, with good success, on-line discussion boards to engage the student who is reticent to participate in classroom discussions. Last fall I invited a group of Wabash alumni doctors to participate in my Freshman Tutorial, "Images of the Physician in Literature and Film." The alumni response was very positive and the course was enriched as a result of the alumni-undergraduate interaction. Most often the main contact alums have with their alma mater is through the advancement or admissions offices. There are too few opportunities for alums to become involved with the academic life of the college and share their experience with undergrads. In this session various aspects of creating and administering an on-line discussion board involving Wabash alumni doctors and college freshman will be described.

Shut Up and Let the Students Learn: Changes in Student Perceptions and Performance in an Active Learning Environment. ***Neil Sabine****, Indiana University East*

A set of active learning strategies that place the responsibility for mastering course content mostly on students will be presented. This session will focus on 1) data on student perceptions of and academic performance in this learning environment, 2) perceptions and performance of faculty teaching in this learning environment, and 3) presenting opportunities and obstacles associated with this learning environment. Data gathered over multiple sections of upper and lower level biology indicates that most students in this learning environment were strongly motivated to perform well, rated the overall learning experience very favorably, and believed they learned more in this learning environment than they would have if they had been lectured to. Faculty generally preferred this learning environment to lecturing but their effectiveness was related to the amount of overall teaching experience they had and the amount of teaching experience they had in this learning environment.

Hierarchy Theory: An Underutilized Helpmate for Understanding Complex Concepts in Undergraduate Biology Courses. ***Jon Gering****, Truman State University*

Hierarchy theory emerged in the 1960s as a bridge between the physical and biological sciences. A fundamental concern of (and motivation for) hierarchy theory was to simplify and explain complex systems such as middle-number phenomena in ecology, evolutionary interactions, and the intricacies of metazoan architecture. Although it successfully explained the nuances of large businesses management, its utility within the biological sciences has never been fully realized. For example, only two hierarchical systems are mentioned in most introductory biology textbooks: the hierarchy of biological organization (atoms → molecules → organelles → cells, etc.) and the taxonomic hierarchy (species → genus → family, etc.). But these are organizational hierarchies; they do not capture the full potential of hierarchy theory to explain the function and behavior of biological systems. The thesis of this presentation is that hierarchy theory – when properly integrated with standard biological pedagogy – can serve as a useful helpmate in students' efforts to understand the function of biological systems. I'll demonstrate the utility of hierarchy theory in clarifying typical biological topics such as DNA replication and translation, ecosystem function, and biogenesis; and its importance for understanding recent developments in macroevolutionary theory, community ecology, and developmental biology.

Biographies of Keynote Speakers

Opening Address
8:00-9:00 PM
Thursday, October 9, 2003

When the Exotic Becomes Invasive: Familiar Questions Wit' Stwange Anthers. ***Dr. Michael Kelrick****, Division of Science, Truman State University*

Michael Kelrick is a Professor on the Biology faculty at Truman State University. He has a B.A. in Geological Sciences from Harvard University, and his Ph.D. in Biology/Ecology from Utah State University, Logan. Michael has a diversity of teaching and research interests and responsibilities, including ecology, field experiences, evolutionary biology, biometry and introductory biology. Michael writes this about his summer experiences: "Recently liberated by the end of my 16th year of university teaching, I look forward to spending the remainder of the summer in the backcountry of the central Colorado Rockies, monitoring exotic plant species in the Snowmass/Maroon Bells Wilderness with a small group of students attending the Rocky Mountain Biological Laboratory. This visceral experience will provide the psychic recharge necessary to power me through the next school year. My return to the withering humidity of the heartland in late August will be assuaged by the tomatoes waiting warmly for me in my garden."

Luncheon Program
1:00-1:45 PM
Friday, October 10, 2003

The Challenges Ahead in Educating 21st Century Biologists. ***Dr. Judith Dilts****, Dr. Burnell Landers Chair of Biology and Professor, William Jewell College*

Dr. Judith A. Dilts is Dr. Burnell Landers Chair of Biology and Professor at William Jewell College, where she serves as chair. Dilts earned her doctorate at Indiana University in genetics. Recipient of both advising and teaching awards, she teaches genetics and microbiology, courses in general education, and tutorials in the Oxbridge Honors Program. Dilts has an active undergraduate research program studying the molecular biology of bacterial endosymbionts in paramecia, and has had students present the results of their research at national meetings. Dilts was, for six years, a biology councilor for the Council on Undergraduate Research, and has served as a consultant for biology, general education, and the sciences for a number of colleges. Active in PKAL since 1990, Dilts has served as Scientist-in-Residence, was Dean of the eight F21 Leadership Institutes, and co-directed and presented the leadership initiatives at the PKAL Summer Institutes. Dilts' session abstract: A recent NRC report, BIO2010: Transforming Undergraduate Education for Future Research Biologists, builds on research in biology and how students learn to make specific recommendations for the education of 21st century biologists. The report highlights the need not only for involving students in biological research, but also for a biology curriculum that integrates concepts from the other sciences in a significant way. The focus of this session is how biology departments might meet the challenges inherent in such curricular demands.

Dinner Presentation
8:00-9:00 PM
Friday, October 10, 2003

Kirksville's Harry Laughlin (1880-1943): Applying Classroom Genetics for the 'Betterment' of Humanity.
***Dr. Philip Wilson**, Penn State College of Medicine*

Philip K. Wilson, M.A. (Johns Hopkins), Ph.D. (London) is a historian of science and medicine in the Department of Humanities at Penn State's College of Medicine in Hershey, Pennsylvania. Resonant of current academic and popular concerns, he is interested in the historical perspectives of how the nature-vs- nurture controversy has shaped humanity. His survey of the nature side of this controversy appeared as a five-volume edited series, Childbirth: Changing Ideas and Practices in Britain and America, 1600 to the Present (Garland, 1996), and he is currently preparing a monograph on Perfecting Heredity: Eugenics as Panacea for Disease in Early 20th-Century America. His previous publications include Surgery, Skin & Syphilis: Daniel Turner's London (1667-1741) (Amsterdam and Atlanta: Rodopi Press, Wellcome Institute of the History of Medicine Series, 1999). Wilson has previously taught at Yale University, the University of Hawaii, Truman State University, and Shimer College, and he continues to serve as the consultant biomedical and health editor for Encyclopaedia Britannica. Currently, he is in the midst of a three-summer Templeton Foundation Fellowship in Oxford where he and 34 other scholars around the globe are exploring the historical and current intersections between science and religion. His Templeton research project, Glaciers, God, and Geography: Neuchatel's Arnold Guyot (1807-1884) at Princeton, explores this 19th-century earth-scientist's success in incorporating both science and religion into his pursuits to understand the history, composition, and meaning of both the earth and its human inhabitants.

Call for Reviewers

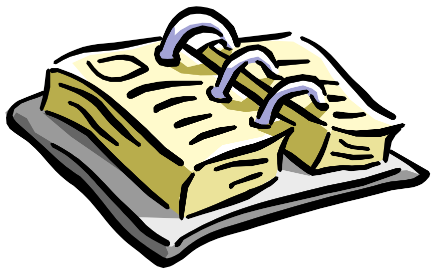
We are looking for persons who are willing to review manuscripts for *Bioscene*. We need reviewers for a wide variety of subject areas. Reviewers should be willing to provide in depth reviews and detailed suggestions for authors concerning revisions necessary to improve their manuscript for possible 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: William Brett, Chair of the Editorial Board, at lsbrett@scifac.indstate.edu.

Call for Nominations

President-Elect, Secretary & 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. Janet Cooper, Biology Dept., Rockhurst University, Kansas City, MO 64110, (816 501 4237, janet.cooper@rockhurst.edu.



Housing Preview

47th Annual ACUBE Fall Meeting
Truman State University
Kirksville, MO

October 9-11, 2003

Lodging: Block of rooms has been reserved at the Days Inn and Shamrock Inn for meeting participants; remember to request the ACUBE block and rate. **IMPORTANT**: Please note there is a Bluegrass Festival in Kirksville on the same weekend, so PLEASE BOOK EARLY

Days Inn
Phone: 660-665-8244
800-329-7466
$45 (plus tax) single occupancy
$50 (plus tax) double occupancy
Request ACUBE block and rate.

Shamrock Inn
Phone: 660-665-8352
800-329-7466
All rooms $50 (plus tax)
Request ACUBE block and rate.

Super 8 Motel
Phone: 660-665-8826
Most rooms about $55 (plus tax) per night

Holiday Inn Express Hotel and Suites
Phone: 660-627-1100
800-HOLIDAY
Most rooms $75 and up (plus tax) per night

Thousand Hills State Park Cabins
Phone: 660-665-7119
Cabins run $55 - $70 (plus tax) per night
Note - these cabins overlooking the lake and book very early; cabins typically have two double beds, some with kitchens.

Camping
For the adventurous, this are camping sites available at the Thousand Hills State Park

Call for Nominations

Honorary Life Award

The **ACUBE Honorary Life Award** is presented to ACUBE members who have made significant contributions and/or service to ACUBE and the advancement of the society's mission. The award is presented at the annual fall meeting of the society.

If you wish to nominate a member of ACUBE for this award, send a Letter of Nomination citing the accomplishments/contributions of the nominee and a *Curriculum Vita* of the nominee to the chair of the Honorary Life Award committee:

Dr. William J. Brett, Department of Life Sciences, Indiana State University
Terre Haute, IN 47809, Voice -- (812) 237-2392, FAX (812) 237-4480
E-mail -- lsbrett@scifac.indstate.edu

REGISTRATION FORM

Association of College and University Biology Educators (ACUBE)

47th Annual Meeting

October 9-11, 2003
Truman State University
Kirksville, MO

Biology for Contemporary Living

Name: (Please print) ____________________

Address: ____________________

City, State, Zip: ____________________

Phone: ____________________ FAX: ____________________

Email ____________________

REGISTRATION FEE: Includes meals Friday-Sat noon., refreshments at breaks, and field trips.

______ $ 75 Regular Member
______ $ 105 New Member (includes dues)
______ $ 105 Non-Member
______ $ 35 Non-Participating guest/spouse (meals only)
______ $ 35 Student (Grad or Undergrad)

______ TOTAL ENCLOSED (Please make checks payable to ACUBE)
(For those registering on-site a $10 handling fee will be charged.)

FIELD TRIPS: Indicate the field trip(s) you plan to attend. Space is limited, register early!

______ Pre-conference crinoid fossil collecting trip to local quarry (Thurs. afternoon Oct. 9)
______ Birding trip (Friday morning, Oct. 10)
______ Restored prairie trip (Friday afternoon, Oct. 10)
______ Post-conference trip featuring open-air flea market, fowl and the Mennonite store (Sat., Oct 11)

SPECIAL NEEDS:
If you have any special dietary or other needs that you would like the meeting organizers to know about, please explain in the space below:

Please mail this form and payment by **September 10** to:

Dr. Nancy Sanders, ACUBE Local Arrangements
Division of Science, Truman State University, 100 E. Normal, Kirksville, MO 63501
Phone: 660-785-4619 Fax: 660-785-4045 Email: nsanders@truman.edu

ACUBE

Association of College and University Biology Educators

NAME: ______________________________ DATE: ______________

TITLE: ____

DEPARTMENT: ____

INSTITUTION: ____

STREET ADDRESS: ____

CITY: ____________________ STATE: __________ ZIP CODE: __________

ADDRESS PREFERRED FOR MAILING: ______________________________

____

CITY: ____________________ STATE: __________ ZIP CODE: __________

WORK PHONE: ______________ FAX NUMBER: ______________________

HOME PHONE: ______________ 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): ______________________

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RESEARCH AREAS: ____

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How did you find out about ACUBE? ______________________________

Have you been a member before: __________ If so, when? ______________

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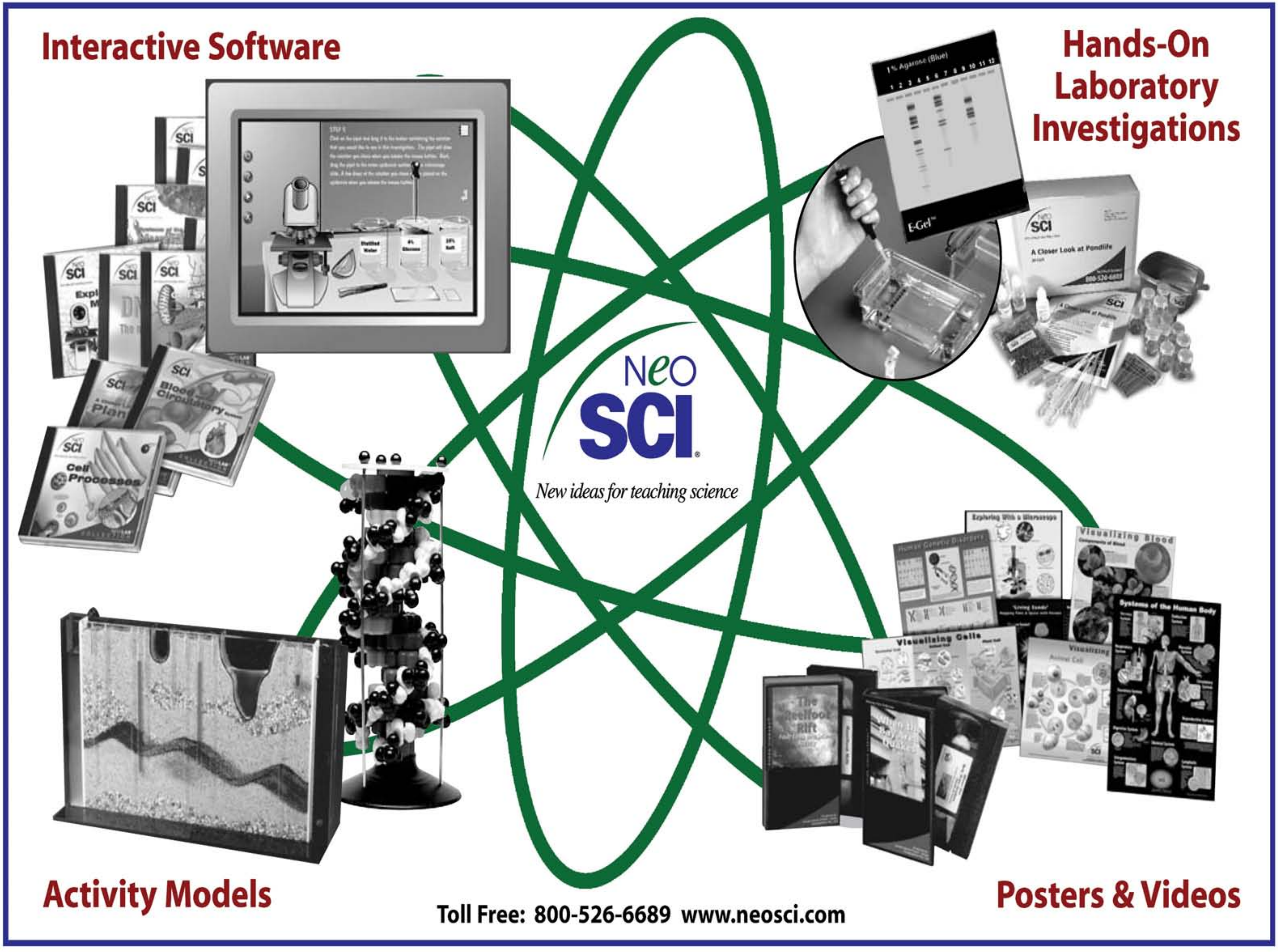

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