Mini Workshop Session I

Bosela, Michael J. *Use of Plant Tissue Cultures for the Demonstration of Plant Mineral Nutrient Deficiency Symptoms*. Indiana University-Purdue University at Fort Wayne, Fort Wayne, IN.

Hydroponics techniques are widely in plant science instruction, especially for the demonstration of mineral nutrient deficiency symptoms. However, hydroponics experiments can be time-consuming to set up since protocols for aeration, algal growth control, and nutrient turnover are all generally required. In light of these difficulties, I have recently evaluated plant tissue cultures as an alternative to conventional hydroponics for the demonstration of mineral deficiencies. Tissue cultures are cultures of cells, tissues, organs, or whole plants, grown on defined nutrient media. These media typically contain both inorganic (mineral) and organic (carbohydrate) nutrition, as well as hormones and gelling agents to 'set' the media. Since tissue cultures are generally sterile and are kept in closed containers that restrict the degree of growth they require little (or no) maintenance. Tissue cultures may also offer handling and viewing advantages, particularly for studies of root growth patterns. In this lab, students compare tomato tissue cultures grown on eight different media; including positive and negative controls as well as six experimental media each lacking one of the following essential nutrients (calcium, nitrogen, phosphorous, magnesium, potassium, and iron). The students collect plant growth data and visual data on the different nutrient deficiency symptoms. The quantitative data (height, weight) is evaluated for statistically significant differences between treatments and keys are prepared for the identification of nutrient deficiency symptoms. The pros and cons of using plant tissue cultures for the demonstration of mineral nutrient deficiency symptoms in undergraduate plant biology labs will be discussed.

Guinan, Judy[1], Jeremy Wojdak[1], & Joseph Wirgau[2]. *Incorporating the "real world" into laboratory exercises*. [1]Biology Department, [2]Chemistry Department, Radford University, Radford, VA.

Too often there is a disconnect between the way science is done in industry and academia and the way it is presented to students in traditional laboratory exercises. Real-word problems are complex and not usually confined to a single academic discipline. In this mini-workshop, we will introduce participants to a multi-disciplinary, long-term, NSF-funded project which attempts to bridge this gap between undergraduate education and the complex nature of real scientific inquiry. Students enrolled in participating courses in four disciplines are trained to collect data from a campus wetland using industry-standard methods commonly used within their disciplines. Data collected are incorporated into the project data repository, available on-line and freely accessible. In this way, data collected by previous courses informs new laboratory/field investigations by students from other disciplines. Students present their findings at an annual project symposium, giving them the opportunity to compare and discuss their findings with students from other courses and disciplines. Biology students are involved in the project in various courses during their university career.

Landon, Beth. *Before the Cradle and Beyond the Grave*. Department of Biology, Oklahoma City University, Oklahoma City, OK.

Life Cycle Assessment (LCA) is described as the evaluation of a product from cradle to grave. With manufacturing moving off-shore and the incorporation of agriculture, recent generations have become increasingly distanced from the means of production. Students are used to a wider variety of fruits and vegetables continuously available than their local land and climate can support; students are used to bags of salad, pre-cut fruit snacks, and individually packaged lunches and drinks; and, students are used to not questioning these conditions. Students who have performed this LCA lab have found that for any product there can be long arms reaching back before the cradle and unintended consequences reaching beyond the grave. In some cases, consumers, who have become more aware of how their buying habits impact the environment, do not realize how regulation of advertizing and the marketing industry itself has lagged behind. This is an exceedingly versatile lab using an assortment of products and a variety of emphases. An unplanned outcome has been that students are often surprised to discover there are employment and internship opportunities in this area especially in state government agencies.

Moore, Susan A. *Gambling with Genetics: Introduction to Probability and Chi Square Analysis.* Duquesne University, Department of Biological Sciences, Pittsburgh, PA

Genetics is a quantitative science and statistical analysis is at the center. Students need to learn how to develop hypothesis that utilize the rules of probability, how to test hypothesis and how to use the chi-square tests. The concepts of probability are introduced in most genetics textbooks using dice or playing cards. The exercises introduced in this workshop promote the use of dice, both straight and weighted dice, and "gene chips" (poker chips) to encourage students to problem solve and analyze data direct applications to Mendelian genetics. The use of loaded dice (students are not informed of this) makes this more interesting as students need to make alternative hypotheses regarding their data. Included in this workshop is how to make your own "loaded dice" and "gene chips."

Thuna, Mindy. *Excuse me, may I interject? - Using current news articles to step into the middle of a scientific conversation*. U of T Mississauga Library, Mississauga, ON.

Science is an ongoing conversation – ideas get transmitted back and forth between scientists (or papers) and ultimately form a network of related papers on any given topic. This lab steps into the middle of a scientific conversation. Using a current news item, students delve into citation searching, determining the main focus of an article, and choosing relevant keywords, valuable skills that every student needs to write effective lab reports on any subject. By using real world examples, students learn how to pick out the 'clues' to help them step into the scientific literature through a starting point that they will encounter in a 'real world' context.

Noel, Tanya & Jennifer Petruniak. *High expectations – Transforming first year students into ethical scientists*. Department of Biology, York University, 4700 Keele Street, Toronto, ON.

In large introductory Biology courses, labs provide a learning environment that is especially well suited for innovations that address developing higher-level learning and intellectual skills. Our goal was to enrich the laboratory component of BIOL 1010; in addition to introducing biological material and lab skills, we focused on creating labbased learning communities to engage students and provide opportunities to reason, work and communicate like scientists. As part of this development, academic integrity was highlighted, with a focus on plagiarism, appropriate paraphrasing, and citation of sources. Computer laboratory exercises ("dry labs") were used for a range of biological activities designed to help students develop and build on these skills, while reinforcing academic integrity. This session will discuss the successes and challenges relating to the curricular changes in the BIOL 1010 laboratory. Lessons learned during our pilot project may be useful to instructors involved in other biological science labs; discussion among participants will provide an opportunity for instructors to identify other applications and modifications that could be implemented to help students at any level develop skills in inquiry, communication and avoiding plagiarism.

Wall[1], Shelley, & Dave Mazierski[2]. *Scientific illustration: a painless introduction to observational laboratory drawing*. [1]Biomedical Communications, Institute of Communication and Culture University of Toronto Mississauga, Mississauga, ON.; [2]Biomedical Communications Program Institute of Medical Science, Faculty of Medicine, University of Toronto, Toronto, ON.

Observational drawing is a time-honoured practice in scientific research. The workshop presenters have developed a laboratory exercise that teaches third-year biology students the fundamentals of observational drawing and sharpens their awareness of form, proportion, texture, and pattern. Students are introduced to simple techniques of sighting and accurate ocular measurement derived from authors such as Phyllis Wood (*Scientific Illustration*) and Betty Edwards (*Drawing on the Right Side of the Brain*). In the lab, they use these techniques to create accurate line drawings of biological specimens such as mammal skulls. Even students who profess to have no proficiency or experience in drawing can produce well-proportioned, carefully drawn illustrations by this means. Materials required for the lab are minimal: pencils, drawing paper, graph paper, grids drawn or printed on letter-sized acetate sheets, a small portable light source, and the specimens themselves. Small mammal skulls or any other dry specimens are suitable. The presenters are faculty members in Biomedical Communications, University of Toronto. They teach a third-year undergraduate course in biocommunication visualization to biology students at the University of Toronto Mississauga.

Mini Workshop Session II

Ford, Rosemary H. *Squirrel Ecology on an Urban Campus*. Biology Department Washington College, Chestertown, MD.

Observational drawing is a time-honoured practice in scientific research. The workshop presenters have developed a laboratory exercise that teaches third-year biology students the fundamentals of observational drawing and sharpens their awareness of form, proportion, texture, and pattern. Students are introduced to simple techniques of sighting and accurate ocular measurement derived from authors such as Phyllis Wood (*Scientific Illustration*) and Betty Edwards (*Drawing on the Right Side of the Brain*). In the lab, they use these techniques to create accurate line drawings of biological specimens such as mammal skulls. Even students who profess to have no proficiency or experience in drawing can produce well-proportioned, carefully drawn illustrations by this means. Materials required for the lab are minimal: pencils, drawing paper, graph paper, grids drawn or printed on letter-sized acetate sheets, a small portable light source, and the specimens themselves. Small mammal skulls or any other dry specimens are suitable. The presenters are faculty members in Biomedical Communications, University of Toronto. They teach a third-year undergraduate course in biocommunication visualization to biology students at the University of Toronto Mississauga.

Gittens, Joanne. *Concept Maps in the Biology Laboratory: A Tool for Meaningful Learning and Assessment*. Robert Gillespie Academic Skills Centre University of Toronto, Mississauga, ON.

The assessment of conceptual understanding in the sciences is a challenge given the time and resource constraints of instructors. However, the concept map (a pedagogical tool for interrelating and organizing information hierarchically) offers an opportunity for meaningful learning and assessment in the biology laboratory and enhanced engagement with and coordination among the lectures, assigned readings, and laboratories of a biology course. This workshop will discuss how "pre- and post-test" concept maps may be used in the biology laboratory to help students: 1) relate topics from all aspects of the course; 2) assess their knowledge and conceptual understanding; 3) develop their writing and communication skills; and 4) prepare for tests and exams. We will also discuss strategies for teaching students how to develop concept maps and teaching assistants how to use formative assessment to evaluate concept maps, as well as share convenient resources with participants.

Karcher, Susan J. *Bioethics Debate and Case Studies in the Teaching Laboratory*. Department of Biological Sciences, Purdue University, West Lafayette, IN.

The cloning of human stem cells; a new prenatal diagnostic method; the safety of genetically modified foods. These are just a few of the topics that are considered by students in a sophomore level genetics and molecular biology laboratory class at Purdue University. Students research a bioethics topic of interest and prepare case studies to debate the topic. Presenting bioethics in the biology laboratory can be important to help show students the applications and significance of the laboratory exercises they do. The bioethics cases stimulate the students interest in this area and help students develop their critical thinking skills. In this miniworkshop, we will present how bioethics topics and case studies to debate are developed in this class. Participants will receive a list of current topics, recent references on the topics, and case studies. Participants will play the role of college sophomores and will debate some of the sample case studies. We will also discuss the experiences of participants who have presented bioethics in their classes.

Leicht, Brenda G. Reverse Genetics: *Identification of Arabidopsis Lines with T-DNA Insertions in a Gene of Interest*. Department of Biological Sciences, University of Iowa, Iowa City, IA.
With the completion of the genome sequencing projects of many model genetic organisms, the next major task is to determine the function of all of the genes. Reverse genetics is a powerful approach to achieve this goal. In this approach, functional study of a gene starts with the gene sequence rather than a mutant phenotype. Using techniques such as insertional mutagenesis, a gene's function is altered and the effect on the organism is analyzed. Because its genome has been completely sequenced, the small dicotyledonous plant *Arabidopsis thaliana* is particularly amenable to reverse genetics. Moreover, many Arabidopsis resources are publicly available and plants are easy to grow. The Arabidopsis research community has generated a large collection of T-DNA insertion lines and the Salk Institute Genome Analysis Laboratory (SIGnAL) has used high-throughput sequencing methods to identify the sites of T-DNA insertion within the genome. The T-DNA insertions not only alter the genes into which they insert but serve as tags for identifying the sites of insertion. As part of a laboratory course in Genetics and Biotechnology, we have developed an exercise in which students use the TAIR and SIGnAL websites to identify T-DNA insertion mutations in a gene of interest. Using the SIGnAL website, they design PCR primers to distinguish plants that are homozygous for, heterozygous for, or completely lacking the T-DNA insertion. This exercise not only introduces students to the power of reverse genetics, it reinforces basic concepts in gene segregation through the genotyping of the F_3 plants from insertion lines.

Miller, Kristen & Cara Gormally. *Strategies for Responding to Student Laboratory Writing Assignments*. Biosciences, University of Georgia, Athens, GA.
It is well documented that writing is an effective means of both engaging students in active learning as well as assessing student knowledge. However, instructors often approach writing assignments with intense dread because of the extensive time anticipated to grade them. Recently, the Biology Division at the University of Georgia (UGA) adopted the guidelines of the Writing Intensive Program (WIP) in two introductory biology laboratory courses (one non-majors course and one majors course). Created by the Franklin College of Arts of Sciences (UGA), WIP guidelines are designed to be adopted by any discipline and aim to help improve 1) students' abilities to compose text, evaluate peers' writing and critically think about writing styles; 2) teachers' abilities to grade and give feedback to student writing; and 3) teachers' own writing. This workshop will provide an overview of the WIP guidelines and then focus specifically on those principles which pertain to improving teachers' abilities to provide students with focused, constructive feedback in a time-efficient

manner. Following this overview, participants will have opportunities to practice using WIP responding strategies to student work. A general question-answer session and whole-class discussion will complete the workshop. A take-home packet of example rubrics, student work, and instructor responses will be provided.

Niedzlek-Feaver[1,] Marianne, Betty L. Black[1]. Patricia Aune[2]. *Protein electrophoretic banding patterns as indices of differential gene activity*. [1]Zoology, [2]Biological Sciences Interdepartmental Program, North Carolina State University Raleigh, NC
This laboratory exercise was always well received by students and instructors and emphasized proteins as products of genes that are turned on or off in different tissues and at different times in development. Students separated proteins by electrophoresis, comparing as they did, the banding patterns produced by denatured proteins extracted from green and white corn seedlings, different parts of the same plant (leaves, stem and roots, flowers and seeds if available) and finally different stages of the life cycle of the fruitfly *D. virilis*. Since students had already investigated the Mendelian ratios produced when different corn plants are crossed, this exercise served to introduce the coming laboratories which treat development in animals and plants. This lab on "gene products" as it was dubbed, was reluctantly abandoned when our enrollments grew to 800 students per term, because the preparation to implement it was so demanding. Consider for example the vast amount of larvae and plant material that would have to be harvested for weeks well in advance of the laboratory with this number of students.

At present this exercise is being converted to a digital resource that could be used as a distance laboratory exercise or at the least, supplement a very basic lab on protein electrophoresis, as one in zoology that requires students use electrophoresis to separate the proteins occurring in a solution containing three common proteins. Participants will be provided with materials (recipes, photographs) necessary to implement this laboratory as a wet lab, web resource or distance laboratory.

Walvoord, Mark. *(Power)Point me in the right direction in lab!* University of Oklahoma, Norman, OK.
Microsoft PowerPoint® software has become a standard method of delivery for many instructors in lectures, while for other people (students and some instructors alike) its very mention continues stimulates brain retching. Some research has been done on its effective use in lectures to improve student learning, so we will quickly review this literature. Then, this session seeks to apply some of those principles to the effective use of PowerPoint in a biology laboratory setting. We’ll discuss criticisms and triumphs of using PowerPoint, and we’ll work together to explore some useful features in the program itself. This session is for naysayers and PPT supporters alike as we critique its usefulness in your lab setting.

Mini Workshop Session III

Catalano, Andrew, & Danton H. O'Day. *A quick, simple, and accurate chemotaxis bioassay*. Department of Biology, University of Toronto at Mississauga, Mississauga, ON.

Cell motility and chemotaxis are important for wound healing, the immune and inflammatory responses as well as a diversity of developmental events. Our lab has developed a simple bioassay method for assessing chemotaxis in the model organism *Dictyostelium discoideum* that uses materials available in any undergraduate or high school lab. In a lab setting, harvesting cells and preparing the chemotaxis assay plates takes less than an hour. The progress of chemotaxis can then be followed over the next two hours or participants can return to "fix" their samples to acquire the chemotaxis data at a later time or date. In this workshop, all of the essential methods for doing the experiments will be demonstrated: the culturing of *Dictyostelium* for cells and to maintain stocks for long term storage; how to harvest cells and set up the assay system; and, how to acquire the data and calculate rates of chemotaxis. While quick and easy, this method has been used by a diversity of research labs worldwide to acquire accurate data on chemotaxis in mutant cells and cells treated with a diversity of biologically relevant chemicals (e.g., Gauthier, Mona L., & Danton H. O'Day, 2001. Cellular Signalling 13: 575-584). In keeping with this, our demonstration will cover chemotaxis of parental and mutant strains to folic acid (used by growing cells to find food bacteria) and cyclic adenosine 3',5' monophosphate (cAMP; used by cells to form multicellular aggregates for asexual development). A short talk on chemotaxis and the life cycle of *Dictyostelium* will include handouts including all methods that are demonstrated with an appropriate list of references. With the information provided, instructors will be able to make use of the availability of the stock center at www.DictyBase.org to acquire a diversity of mutant stocks, information on chemotaxis in *Dictyostelium* and specific references to develop labs that they feel are most appropriate to their course(s).

Hendrickson, Triscia W. & Lawrence S. Blumer. *Implementation of Peer-Led Team Learning in an Introductory Biology Course*. Morehouse College, Atlanta, GA.

Peer-Led Team Learning (PLTL) is a problem-solving method that has been widely and successfully used in Chemistry courses. We have adapted this model for our Introductory Biology Course at Morehouse College. In each hour and one half PLTL workshop that immediately precedes a given laboratory section, students are engaged in team efforts to solve problems. These weekly workshops are led by upperclassmen peer leaders whom have previously done well in the course. This initiative is coordinated by a faculty member who meets weekly with the peer leaders to review and prepare for the upcoming workshops. The traditional teaching model centers on a lecturer disseminating information to a group of students in a classroom with little or no opportunity for student involvement. While lectures remain an essential part of the teaching-learning process, there are more effective ways of engaging the students. PLTL offers such an opportunity, giving students ownership of the material and allowing them to take a more active role in the learning process. PLTL has significantly improved the success of students in our multi-section first semester Introductory Biology course. We will present a sample PLTL workshop so participants can see how this learning process works. Also, we will provide some guidance on how to develop workshops for and implement in your own courses.

Jack, Martha. *Bringing the Lab into Your Lectures*. Biology Department, Indiana University of Pennsylvania, Indiana, PA.
The days of chalkboards filled with lecture notes are giving way to PowerPoint presentations and video clips, yet for biology courses without a laboratory component, the excitement of live, real-time experiences is still missing. Even when the lecture is accompanied by a lab requirement, there are only so many topics that can be investigated per semester in the lab sessions. To incorporate more demonstrations, mini-lab experiments, and excitement into the lecture portion of a course, the document camera is an ideal tool. Using it effectively will not only serve to illustrate course content in attention-grabbing ways, but it can also encourage better student attendance. This mini-workshop will run through several brief, easy demonstrations, provide a list of additional suggestions, then follow up with a brain-storming segment that will expand the repertoire of ideas for bringing the biology lab into the lecture room.

McMahon, Karen A. *Updating the Taste Test for the A&P Laboratory.* Biological Science, University of Tulsa, Tulsa OK.
Supertasters, medium tasters, and nontasters can be distinguished by PROP (6-n-propylthiouracil) taste papers. Supertasters have a stronger reaction with higher densities of fungiform papillae and avoid eating bitter fruits and vegetables. Three SNPS have been identified in the *TAS2R38* gene which codes for one bitter receptor in taste buds. PAV (proline-alanine-valine) is the dominant taster haplotype and AVI (alanine-valine-isoleucine) identifies the recessive nontaster allele. Nontasters are AVI/AVI whereas PAV/PAV is more sensitive to PROP than PAV/AVI Students investigated if reaction to unsweetened grapefruit juice predicted PROP status, papillae density, and haplotype. Students reviewed prepared microscope slides to identify papillae and taste buds. Blue food coloring was swabbed on the anterior tongue to distinguish blue filiform papillae which lack taste buds from nonstaining fungiform papillae with taste buds. Density of fungiform papillae was calculated for an area encircled by an adhesive reinforcement labe. DNA was extracted from cheek cells; a 221 nucleotide base region of *TAS2R38* was amplified; and digested by *Hae* III which cuts PAV but not AVI. RFLP were separated on a 2% agarose gel and the genotype scored. Eighty percent of supertasters and 39% of medium tasters disliked grapefruit juice. Nontasters accounted for the highest percentage (38%) of those who liked grapefruit juice. Mean papillae densities were significantly different (ANOVA, $p<0.05$) at 75.83/cm^2 (supertasters), 61.44/cm^2 (medium tasters), and 50.16/cm^2 (nontasters). As predicted, most supertasters (71%) were identified as PAV/PAV, 64% of medium tasters were PAV/AVI, and 71% of nontasters were AVI/AVI.

Meir, Eli. *Hardy-Weinberg lab in EvoBeaker: Help with new study on teaching Hardy-Weinberg equation*. EvoBeaker, Ithaca, NY.

EvoBeaker is a widely used commercially distributed program (hundreds of universities) for teaching both micro and macro-evolutionary biology. Students are given simulations that correspond to published evolutionary biology studies, and have tools to do experiments on those simulations. Workbooks guide the students through these experiments in ways that teach them important evolutionary concepts. We have an NSF grant to redo our "Hardy, Weinberg, and Kuru" lab, an upper level lab on the Hardy-Weinberg equation. In this workshop I will gather feedback on teachers impressions of where students get confused (and student misconceptions) around Hardy-Weinberg, present a misconceptions test we have written to for feedback, and present our ideas for revisions to our Hardy, Weinberg, and Kuru lab. At the end of the session, I will be recruiting people to assist with the study by using the revised lab in their classes during the 2008 / 09 school year. I will also show the current Kuru lab, and show our new version of our introductory biology Sickle-cell Alleles lab, which covers hardy-weinberg, selection, and drift at a more introductory level. Participants will have the opportunity to play with both labs themselves.

Ratcliff, Rachel. *Quick Ecology Experiments for Introducing the Scientific Method.* Department of Biological and Health Sciences, Texas A&M University – Kingsville, Kingsville TX.

The steps of the scientific method are covered in nearly all introductory Biology courses. Having students put these steps into practice is invaluable in their understanding and retaining the concepts of this important process. In this exercise, students will get to put their observational and questioning skills to work. They will form hypotheses, design quick experiments, draw conclusions, and give a brief presentation over their work, all within an 1 ½ hour period. This exercise has been used in both non-majors and mixed majors' courses at Texas A&M University – Kingsville to introduce the scientific method and can be conducted with limited resources and set up time. This exercise provides an opportunity for students to use the scientific method without getting weighed down by an extensive experimental design.

Mini Workshop Session IV

Barrette-Ng, Isabelle & Don MacMillan. *Gaining a deeper and more integrated understanding: linking Mendelian genetics with molecular genetics using web-based bioinformatics tools*. Department of Biological Sciences, University of Calgary, Calgary, Alberta.

In most universities and colleges, the traditional model of teaching introductory genetics begins with a description of classical Mendelian genetics that is followed by a somewhat abrupt transition to modern topics of molecular genetics. Bioinformatics, if covered at all in an introductory course, is usually presented as an add-on topic towards the end of the course. We re-evaluated this traditional model and asked whether the teaching of traditional Mendelian and molecular genetics topics could be improved by integrating the use of bioinformatics tools into the existing curriculum. To address this question, we implemented a month-long inquiry-based, experiential learning laboratory exercise. In this exercise, students investigated classical and molecular genetics aspects of a genetically inheritable disease using basic bioinformatics science tools such as the Pubmed, OMIM and BLAST databases, as well as more practical and applied tools such as the Google Patents search engine. Our experiences in implementing this inquiry-based, experiential learning approach in a large (>500 students), second-year undergraduate, introductory genetics course for biology majors revealed a number of challenges and opportunities. A particularly important element in the success of our experiment in large enrollment classes was a comprehensive plan to use the university library's resources and expertise. This enabled us to develop an interactive, hands-on workshop to expose students to bioinformatics tools that was reinforced throughout the classroom lecture component of the introductory genetics course. This exercise led to a high level of student satisfaction and a more integrated introduction to classical and molecular genetics.

Kurabi, Bochra & Anne Cordon. *Adding student assessment to ABLE peer review*. Department of Biology, University of Toronto at Mississauga, Mississaga, ON. Since 1979, the Association for Biology Laboratory Education (ABLE) has promoted innovative and reliable experiences in undergraduate biology laboratories. Developing and teaching an effective laboratory requires skill, creativity, and hard work on the part of the science educator; all of this effort is done with the intention of engaging students to learn science by "doing" science. The aim of this project has been to look at how undergraduate biology students assess laboratory exercises—what do students think is the role of labs and how do they rate various exercises? This project was designed, implemented and analyzed by Bochra, a fourth year University of Toronto Mississauga student conducting this research for an advanced individual project course in science education.

In order to receive student feedback, an online survey was constructed to ask students to assess three laboratory exercises that will be presented as Major Workshops at the 2008 ABLE conference. More than twenty student volunteers from all levels (first year through fourth) were asked to evaluate lab content, lab goals, lab audience, instructional method, and the lab assessment. The findings will help develop an understanding of the students' perception of labs in general and the design of specific labs. In addition, even preliminary results support the "common knowledge" that perceptions and needs of first year students differ from advanced students!

ABLE has always encouraged participants to actively partake and share ideas on improving the laboratory experience. The point of this project and presentation is to add the student voice to the sharing process. The end result we hope will benefit both UTM and ABLE. We plan to use this student survey to assess UTM labs, but will also offer this student survey template to be used as a tool for future ABLE conferences. Though many workshop authors have done student assessment at their home institution, including student assessment from the ABLE host institution will add another dimension to the process of peer review for labs presented at ABLE conferences.

Nickle, Todd. *Riddles as a Metaphors: Illustrating the Role of Experimentation in Constructing a Scientific Theory*. Mount Royal College, Calgary, AB.
Students in science – particularly in their first year – can have difficulty understanding how the results of experimentation are used to construct a theory. Science is a process: it's not about being right, but rather is a way of thinking about the world. Science is a tool: it allows us to systematically approximate "reality" by creating models of that reality (theories). This presentation will outline an exercise in class that gets the participants to think critically about how they solve a riddle (such as classic *The Hobbit* riddles) and draws parallels with how science uses experimentation to come up with "answers" (such as theories). Each line or stanza of the riddle provides a little more information about the answer. Each set of experiments provide results that inform the construction of a theory. The metaphor of riddles can also be extended by providing challenges that have ambiguous results. A riddle with more than one possible answer illustrates how scientists deal with competing theories: additional experiments (stanzas) can be created to distinguish between riddle answers; further experimentation is used to discard theories that "don't fit".

O'Day, Danton H. *FAMIS Animations as Teaching Tools and Laboratory Exercises: Their Value and How to Make Them*. Department of Biology, University of Toronto at Mississauga, Mississauga, ON.
If a picture is worth a thousand words, a thousand sequential pictures are worth at least a million. In this ABLE MINI Workshop, I will demonstrate a simple method for making biological animations. First I will outline all of the important pedagogical components that comprise a meaningful educational animation then outline the sequence of steps in making a "FAMIS" animation. Since the method is based upon the use of PowerPoint™ plus the capture program CamTasia Studio™ any teacher or student has the ability to make these animations immediately without any further training. I will demonstrate the quality and diversity of animations that can be made using my own and several student animations. Then I will discuss how such animations can be used either as vehicles to facilitate the learning experience during a laboratory session or as a laboratory or tutorial exercise itself. During the presentation, I will also provide data from some of my published research demonstrating the value of animations in short-term and long term memory retention in the biological sciences (O'Day, Danton H., 2006. Animated Cell Biology: A Quick & Easy Method for Making Effective High-Quality Teaching Animations. CBE: Life Sciences Education 5: 255-263; O'Day, Danton H., 2007. The Value of Animations in Cell Biology Teaching: A Study of Long-Term Memory Retention. CBE: Life Sciences Education 6: 217-223).

Smith, Pliny A. *Phenotypes to genotypes using* C. elegans. Biology Department, Lake Forest College, IL.

The free-living roundworm *Caenorhabditis elegans* is an excellent organism for demonstrating genetics and connecting phenotypes to genotypes. This mini workshop Will demonstrate how students can make phenotypic observations of a series of unknown rm strains and assign a genotype to each. A number of strains can be identified with Certainty by an initial observation and comparison to wild-type worms using a stereo microscope. A few strains appear identical to each other, and will require students to design simple experiments to distinguish the possible genotypes, such as a genetic cross or incubation at a restrictive temperature. This workshop will demonstrate how to obtain and culture useful strains and how to implement the lab to encourage students to design appropriate tests for determining the genotypes of their unknowns.

Yezerski, Ann. *Using Microfossils as the Basis for a Laboratory Module on Topics in Evolution and Ecology (In Memorial of Charlie Drewes)*. King's College, Wilkes-Barre, PA.

At the Annual ABLE meeting in 2005, I had the pleasure of attending the workshop presented by Charlie Drewes on Devonian microfossils. Since that time I have used the resources provided during this workshop to develop a three-week laboratory module for freshman. During this mini-workshop I will summarize how these tiny fossils are an excellent teaching tool for evolution and ecology. The techniques and concepts covered include microscopic manipulation, the formation of fossils, geologic history, construction of phylogenetic trees, calculating a diversity index, environmental sampling, and how the tree of life shows both current and historic relationships amongst organisms. The laboratories are arranged in three major sections: 1) identifying, sampling, and calculating a diversity index on the fossil sample, 2) learning how to construct a phylogenetic tree, 3) combining the first two exercises with additional information, such as web resources and observations of extant relatives of the fossils, to create a phylogenetic tree for these Devonian organisms. These exercises can be used individually, or combined as an ongoing project that touches on many of the topics emphasized in a first year course.