Hybrid Format Allows Application, Integration and Promotes Active Learning in Introductory Biology

Marianne Niedzlek-Feaver and Betty L. Black

Dept. of Zoology Box 7617,
David Clark Labs,
CALS, North Carolina State U.
Raleigh, NC 27695

mnfeaver@unity.ncsu.edu
betty_black@ncsu.edu

Abstract: Freshman biology is currently taught in a standard lecture-based format in classrooms of ~200 students. Lecture-based teaching in concert with "recognition" multiple-choice exams encourages students to memorize and regurgitate. There is no formal attempt to connect the laboratory exercises with the major concepts covered in lecture. Thus, students do not develop a real understanding of the material, cannot apply knowledge to problem solving, and retain little of what was taught. The plan is to replace the current offering with a hybrid format. Students will acquire the basic material from a rich, highly interactive, course web site in concert with readings from their textbook. Hands-on experience will be provided by a three-hour laboratory that meets once a week. Because the web instruction is self-paced, much more can be done to integrate the weekly laboratory experience into the course content as compared to a standard lecture. Students also will meet in small sections of 25-30 once per week in a 75 min class period during which the instructor conducts group exercises, problem solving and/or discussions relevant to the current material. This format allows the instructors to prepare students for the coming lab as well as to review results of the previous laboratory. Thus, the classroom session not only provides another medium for integrating lecture and laboratory, but more importantly, for extending the laboratory experience. Although these problem-solving activities will be designed as part of the new hybrid course format, they can easily be modified into homework assignments or laboratory activity sheets. We look forward to your feedback on our approach in general and our attempt to offer an active learning and truly integrated experience for our freshmen life science majors.

Introduction

Freshman biology is currently taught in a standard lecture-based format in classrooms of ~200 students. Such an environment does not encourage a deep understanding of concepts and does not fit the learning style of most 21st century students. Lecture-based teaching in concert with "recognition" multiple-choice exams encourages students to memorize and regurgitate. They then lack a real

understanding of the material, cannot apply knowledge to problem solving, and retain little of what was taught.

Upon reflection, we realize that the introductory experience with regard to its ability to provide structure and time for skill building has been severely compromised over the last two decades. Many of us experienced biology courses that included problem sessions and two laboratories per week. The time for hands on activity and problem solving has decreased by more than half.

Financial constraints as enrollments rise have caused the shrinking laboratory experience to default to activities that ensure consistent but often simply illustrative demonstrative examples of basic concepts. Yet we are asked to prepare students for positions that will continue to require more technical expertise. Students begin to question why they should even be spending three hours a week in laboratories that are weak renditions of concepts treated in more depth in lecture

Solutions must be sought that are fiscally responsible yet provide more application, practice and extension of basic concepts as treated in typical "lectures". All components of the course, such as lecture and laboratory must be carefully and successfully integrated so that retentive learning is the objective and duplication that does not enhance understanding is avoided since budgets will probably continue to spiral downward and enrollments upward.

We plan over a period of several years, to convert the current lecture style of teaching Bio 181 and 183 to a hybrid format (also called "blended" learning). The new format would combine Internet technology with small-group interactions between instructor and student, thus merging the best features of a large University with a "small college" atmosphere. The result will provide students with a higher-quality learning environment than currently exists, while reducing the resources required to teach large numbers of freshmen.

The Proposal

We are offering a hybrid or blended learning experience that emphasizes active learning, to 60 introductory biology students this fall semester.

The website, interactive content replaces the traditional "lecture":

Students will acquire the basic material from a rich, highly interactive, course web site in concert with readings from their textbook. The web site contains a mix of text, audio, interactive video, and animations to illustrate concepts and add interesting details.

Examples:

Learning objects used to introduce concepts vary from simple interactive activities to more complex simulations

1. While learning about microevolution, students are presented with examples of scenarios where genetic drift or selection would be the most likely agent of change. They select the most likely agent and obtain appropriate feedback if their answer is wrong. Students then tackle a simulation of industrial melanism where they try to capture different color morphs on various colored backgrounds.

2. Below are examples of learning objects from the material on cell structure.

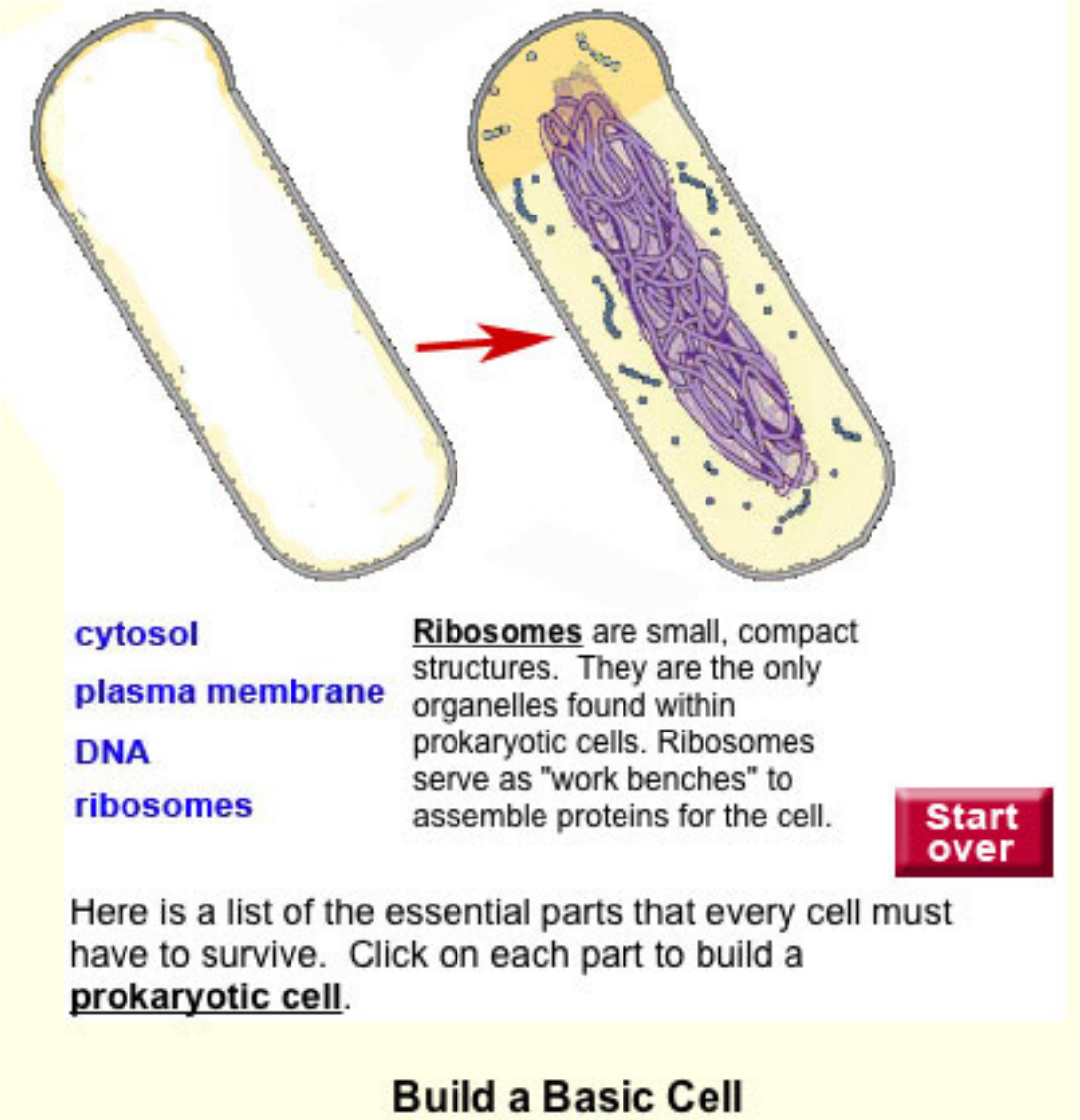

Figure 1. This activity actually starts with a blank screen with tersm and instructions. Students then add parts in turn, perhaps first choosing the cell membrane and adding structures until they have a complete diagram of a prokaryote.

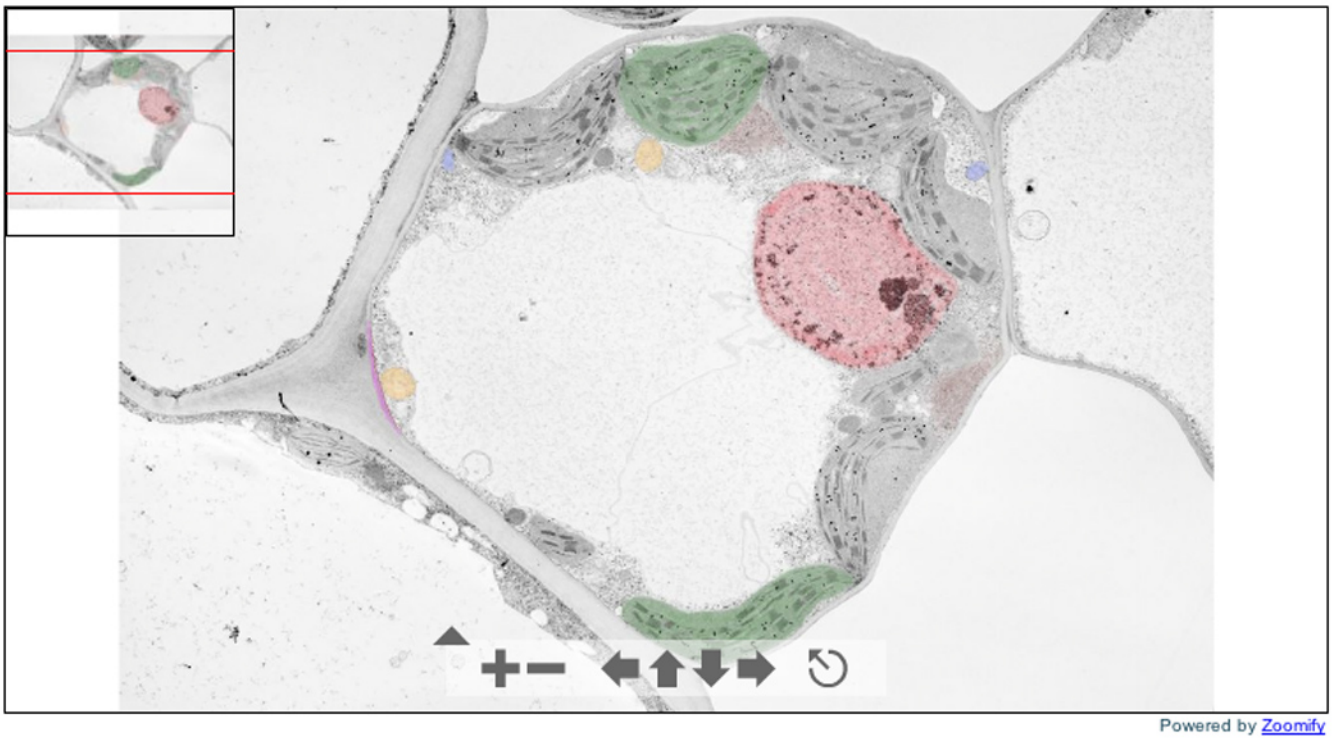

Figure 2. In the activity pictured below students click on an organelle (color) to learn more about that organelle and its substructure.

Usually students are asked to read two to three outside papers per topic; there are also news worthy optional readings to engage student and raise motivation, all available on the website or easily accessed through appropriate links.

Each weekly topic is accompanied by a web-based quiz that tests student mastery of the week's material. Most of the quiz is graded automatically and provides feedback for questions answered incorrectly.

Classroom session or interactive discussion:

Students meet in small sections (30 students) once per week in a 75 min class period during which the instructor conducts group exercises, problem solving and/or discussions relevant to the material covered during the previous week. Students will be required to apply their knowledge and demonstrate an in-depth understanding of concepts, including those covered in the previous week's laboratory. By doing such these activities will provide structure, extending and integrating the laboratory and website explorations.

Examples:

1. After exploring the basics of the scientific method individually via the web site, students are broken up into small groups to explore articles that will review and extend their exploration of the practice of biological research. In laboratory, students will design experimental studies so the papers chosen for the classroom session focus on tests of hypotheses making use of correlative data or models. Some students are assigned papers that treat the history of some medically important discoveries such as the discovery of effective vaccines for polio and the documentation of worthiness of hand washing in preventing mortalities in delivering women from childbed fever. Other small groups of students tackle papers that treat in general the "human element" and its influence on scientific research, good and bad. Students explore web sites discussing the influence of patents on certain medical practices, recruitment protocols for current clinical trails as well as laws once spawn from an 20th century eugenics movement in this country. In this way students will extend their basic knowledge and obtain a better appreciation for biological research as practiced in the real world.

2. The classroom session on cell structure and function will open with a round robin where students in turn will have to draw or label an organelle drawn by another student in the cell shells available. This provides review and peer pressure to have completed the Internet component successfully before the problem session.

Students then must deduce the function of specialized cells picture or diagram a cell that meets a specific function such as exporting large quantities of protein. This part of the exercise provides application and testing of their knowledge of organelle function and extends the visual experience provided by laboratory

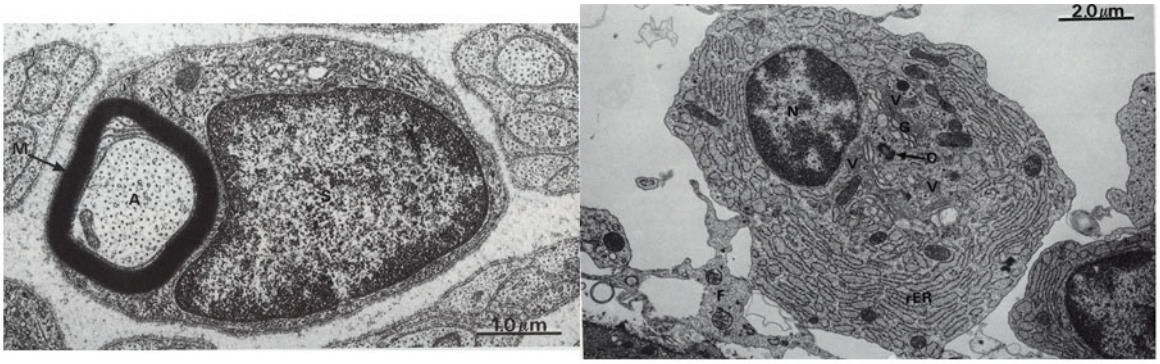

Figure 3. Electron micrographs used in the exercise on identifying cell function.

A second 75-min period of the week will be used to administer the three major exams for the course. This second meeting will also offer the students to ask questions they may have about any facet of the course, “web site activities, classroom activities or laboratory. Thus most of these meetings will be considered optional, but encourage one-on-one interactions between instructor and student and provide a formal opportunity for individual and/or group tutoring.

Laboratory:

In most cases, the classroom sessions will precede any laboratory treating the same material. We hope then that students are fully prepared for their laboratory activities. This assurance that students have already mastered the basic concepts treated in laboratory should eventually enable us to offer more challenging laboratory experiences. Students may also bring any concerns about their laboratory experience or assignments to the second classroom session of the week. In this way the laboratory experience becomes a fully integral and valuable part of the course.

A consistent effort is made to integrate past with present content. For example, one of the readings that deals with microevolution discusses the different types of data used to test the hypothesis of industrial melanism, and so acts as a reflection on the material dealing with the scientific method learned previously. We try to choose examples that can be used to illustrate several different concepts helping student better relate important concepts presented throughout the course. The enzyme deficient in Tay-Sachs is first used as an example illustrating the importance of enzymes. When we discuss cell structure it will be used again to illustrate the importance of cell compartmentalization because this defect results in a malfunctioning lysosome. Finally students will follow the inheritance of this disease when they tackle problems dealing with Mendelian genetics. It also serves as yet another example of how the DNA inherited by offspring can "simply" be instructions for proteins, a major theme introduced early and stressed throughout the course.

Evaluation

We hope to evaluate our efforts in various ways. Evaluators are making several visits to the course. They interact with students informally during activities and will also conduct more formal focus groups throughout the semester hoping to access student response to the hybrid format. Students in these sections will be tracked throughout their career and periodically asked to reflect on their experiences in this section. They will also be asked whether their experiences in the hybrid section in any way better prepared them for future coursework. The scores on major exams of students in the hybrid sections will be compared to those in traditional lecture sections. Introductory biology is a two-semester course and to test for relative retention, students from the traditional lecture and the hybrid course will be given a review exam at the beginning of the second semester.

We value your input on our efforts. For access to the website or copies of our exercises in exchange for your evaluation of such, please contact the authors.

About the authors

Dr. Marianne Niedzlek-Feaver received a B.S and M.S. in Biology from the University of Illinois and a Ph.D. in Zoology from the University of Michigan. She is currently an Associate Professor of Zoology at North Carolina State University. An evolutionary ecologist, she is interested in identifying factors that shape the mating systems of grasshoppers and katydids. She currently teaches Introductory Biology, Evolution, and Invertebrate Zoology.

Dr. Betty L. Black received a B.A. degree in Biology from Lindenwood College, an M.S. degree from Vanderbilt University, and a Ph.D. from Washington University (St. Louis). She pursued postdoctoral studies at Washington University Medical School and is currently a Professor of Zoology. She conducts research on development of embryonic intestine and teaches courses in Developmental Anatomy, Functional Histology, and Animal Diversity.