Alternate Teaching Methods in Vertebrate Physiology Lab: Time to STOP and Learn It Again For the First Time

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Introduction

Most of us who teach biology labs and, especially, upper level physiology labs know that the semester can turn into a rat race. Just thinking of all the neat experiments we can do to illustrate skeletal muscle contraction or nerve impulse conduction or heart function presents the problem of which ones to chose. However, the semester is never long enough to do all the exciting, hands-on, awe-inspiring physiological experiments and write and grade all the detailed lab reports so that all the fabulous concepts presented in lecture can be illustrated in lab and etched permanently in the student’s minds. Afterall, the purpose of the lab component of any course is to illustrate the concepts presented in lecture and to involve the students in the scientific method directly.

Being a relatively new “doc on the block” and having taught several semesters where each week the students had a new lab experiment to perform and a companion lab report due for that lab the following week, I began to sense that a vital part of the learning process was missing. The lab reports were satisfactory in telling me how each student interpreted the results, but I was not able to involve as much critical thinking, problem solving, basic data and statistical interpretation or discussion of current issues in physiology that I thought were necessary components of a majors’ physiology course. The purpose of this paper is to present a discussion lab period as a break in the action and as a valuable time for dialogue, review and experimental analysis.

In an effort to integrate knowledge that biology students have learned in my courses and in other courses, I added 4 discussion periods to my majors physiology course in place of several labs that I and past students thought were expendable. These 2 hour discussion sessions provide opportunities to do several things that I was unable to do previously in this course. I usually use each one of the following examples at least once in these discussion sessions each semester.

Review of Lecture and Lab Concepts

First, these sessions allow both the instructor and students to stop and take a breath, to look back on what has been covered, to look ahead to see what is coming and to discuss the implications and significance of each topic. Second, it allows me to question each student in an informal setting about their interpretation of data or concepts. This time lets me gauge whether all these marvelous, intricate experiments were illustrating the concepts that I thought they were. I ask the students directly what they thought of the procedure and to suggest improvements for future labs. Without exception, I get feedback about the beneficial and problematic aspects of each lab. Many of these I have used successfully in subsequent labs. We discuss the main concepts and trends that the experiment revealed and, often we try to explain logically some unusual data or “points that don’t fit on the curve, Dr. Davis”. We also talk about similar data presented in published reports and why our
data may be the same or different. These exercises foster critical thinking, data interpretation and personalized communication not only between the instructor and the student but among students. It not only provides me with useful feedback from students, but also lets students hear how other students understand a concept or an experimental result rather than the almighty instructor’s “words written in stone”.

Another outcome of these discussions is the opportunity for students to put this information into other, more applied or personal situations. For example, if this frog muscle contracted with this rate and showed such much fatigue, how will my leg muscle respond at track practice or what internal physiological and external environmental conditions are present in my leg that may produce different results? How does an injured muscle respond to similar stimulation?

Critical Analysis of a Published Article

Another exercise that I have used successfully in these discussion sections is the critical analysis of a published article. I try to choose articles that involve a specific concept that was mentioned in lecture or in lab previously. Sometimes I give the article to the students several days in advance or sometimes they get a paper to analyze without prior exposure to its contents. Since lab reports follow a similar structure, we first look at the overall format of the paper. What is included in the introduction? How does the author get the reader interested in the topic and encourage the reader to continue? Is the purpose or hypothesis stated clearly? Are the hypotheses really tested? Are the figures and tables presented clearly? What do you see as unclear or confusing? How could it be adjusted or presented better? What are the author’s conclusions? Do you agree with them? Does the article present new and useful information? Was the money spent in doing the research used successfully in your opinion? An example of an article that I have used is one on autoregulation in the kidney and the effects of dietary protein (Murray and Brown, 1990). I also use reprints of my own publications in this exercise. It seems to bring the whole experimental and writing process closer to home. Does Dr. Davis indeed practice what he preaches?

Design An Experiment

We get a chance in these discussion groups to go another step further. I ask the students to design experiments that will test some lecture concept or add to results that were obtained in a previous lab. I think it is useful also to present some hypothetical circumstances and design an experiment around them. One of my favorite examples is the Weekend Protein (WP) experiment. First, we reveal what we know about WP. It appears in the blood on Friday afternoon. It definitely influences many bodily functions while it is present and yet it is definitely gone by Monday morning. How do we measure it? Where is it made? What is its stimulus for production? What happens on Sunday? What do we investigate first? What is the simplest experiment to do first? What is a well-designed experiment? What hypothesis is being tested? This always generates much student enthusiasm and gets them to use their imaginations a bit also.

Another example that I have used is further investigation of kidney function. I propose that a small steroid molecule has been isolated that delays or reduces muscle fatigue by 25%! (All the weight lifters and athletes in class prick up their ears.) However, the molecule is cleared by the kidney in one pass very quickly. What can we do to try to get it to stay in the body longer from what we know about kidney function? What are some in vitro tests we could do to help us further understand its potency or its specific tissue effects? I have small groups work on these experimental proposals and then in the large group they present their experiments and their justifications for choosing their approach. Roaring, somewhat-combative verbal exchanges have resulted several times in the large group session as several sets of students argue for the benefits of their approach. Suddenly, the instructor realizes that critical thinking, the scientific method,
physiological concepts and experimental designs are flying around the room simultaneously. Suddenly, the purpose of the whole exercise becomes obvious - just what the doctor ordered! These types of exchanges do not occur every time but they do occur quite frequently and they make the effort of teaching quite rewarding.

**Discussion of Controversial Current Issues**

Another exercise that has been very successful is discussion of current controversial topics in physiology, medicine or public health that I have mentioned or that students have interest in. Again, as we rush through the semester to cover as much physiology as possible, we may briefly mention fetal tissue research or the use of anabolic steroids in athletics or spinal cord injury research (see Table 1 for a list of other topics) but we usually do not get a chance to ask the quietest member of the class how he or she feels about the problem. It is in these sessions that I get a much clearer picture of which students are thinking, what they are thinking about, how they are thinking and what some of the more reserved students’ opinions are in an informal setting. In these sessions not only do students get a chance to express their opinions, they get feedback from other students which shapes their final overall knowledge of the topic at hand. Also, if they have not yet formed an opinion, they can listen to others, mold their opinion and eventually argue for it. Most of the students in my classes participate actively in these discussions. Topics start out physiologically oriented, but many times branch into moral and religious decision-making discussions. I usually let these tangents develop for a while, but try to summarize what has been said and refocus the discussion. I feel that discussions of moral and religious implications of these topics are valuable because here the students have the opportunity to express themselves in a group that has a common background of biology and general education. As biology majors, exposure to these controversial topics is essential. They will be faced with many similar situations and questions in their own lives. Through this experience they may be able to make a sound, logical decision or educate someone else about a specific topic.

My role as the discussion moderator is very important and must be emphasized here. I feel the moderator should be a neutral party, who, despite having his own opinions, controls the breadth of the discussion without forcing his/her opinion upon the students. All sides of the topic can be addressed this way and the students are free to accept the side that they agree with. Many times during these discussions many new questions are asked and I purposely encourage the students to answer them themselves by further investigation if they so desire.

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Figure 1. An Outline of Questions to be Raised during Discussion of Euthanasia

Initial Question to Students: What are two distinguishing, physically measurable events that signify the end of human life?

Discussion of the following responses to initial question:
-no brain waves but a pumping heart from life support machine?
-length of time heart pumps or breathing continues or brain waves are measurable AFTER life support machine is disconnected?
-irreversibly unconscious but brainstem still stimulating breathing rhythm?
-functioning brainstem?
-beating heart?
-breathing?
-warm skin?
-ability to feel - anything?
-ability to move eyeballs?
-presence of basic reactive reflexes?
-measurable pulse?
-every last brain cell “dead”?
-some areas of the brain more important or vital than others?
(from Rosenthal, 1992)

Case Histories in Human Physiology
I also use examples of human case histories that give an added dimension to learning about physiological processes. After I have spent some time in lecture and lab presenting and discussing normal physiological function, both the students and the instructor have found it beneficial to examine abnormal physiological circumstances. A good series of human case histories is presented by Van Wyensberghe and Cooley (1990). These are arranged by organ system and are followed by a set of questions about the patient’s condition. An answer key is also available from the publisher. The students get acquainted with medical terminology, units of measurement and different methods of detecting abnormal physiological function. Some of the students that are medically oriented enjoy “playing doctor,” but others have mentioned that this exercise is beyond the scope of the course. I remind them that they may be on the receiving end of this information some day and a little time spent here trying to understand the situation may aid in their future decisions.

Possible Drawbacks and Disadvantages
I have conducted these 2 hour discussion sessions very successfully with a maximum of 20 students and a minimum of eight students per session. I would predict that the effectiveness of these sessions will decline as the number of students increases beyond 20 or drops below 5. If you think lecture is taxing or organizing the equipment and procedures for the weekly lab is a major aerobic exercise, preparing for and conducting these discussion sessions is equally energy consuming. One difference between lecture and lab is the element of the unpredictable or unknown that is always present in these discussions. In lecture or lab the instructor has a planned set of notes or procedural steps that are covered and a relatively narrow path is followed. In these discussions, each group of students respond differently and the path of discussions or questions will go in opposite directions. The instructor must simply go with the flow, be flexible and try to focus the discussions as is necessary. This unpredictability may be a problem for some instructors. I have found it to be a stimulating and fun experience.
Conclusions
The introduction of discussion lab sessions into my majors physiology course has been beneficial for the instructor as well as for the students. The most important aspect of these periods is the increased level of bidirectional communication between students and instructor. I usually use questioning and short written quizzes in lecture. Now I can get much more thorough information on each student and how they are doing in the course in general. As a result, this information permits me to evaluate student performance much more accurately. These sessions establish a breathing period for students and professor. Through these sessions a much more complete, interactive learning process for the students and instructor can occur.

Literature Cited


*Populus*, an NSF-sponsored package of teaching software for courses in ecology and evolution, is available by anonymous FTP on the Minnesota ecology server, ecology.ecology.umn.edu (134.84.102.1), in the directory /pub/populus. The package runs under DOS on Intel-compatible computers and contains 50 simulation models central to a contemporary understanding of ecology and evolution. Each model includes a narrative introduction, context-sensitive help, an input screen that allows students to manipulate the values of model parameters, and graphical outputs. The software can be duplicated without charge for students and colleagues. Users who lack the internet access required to obtain a free copy by FTP can acquire the program on disk for $10, payable to the University of Minnesota, from:

**Don Alstad, Ecology, Evolution & Behavior,**  
**University of Minnesota**  
**1987 Upper Buford Circle**  
**St. Paul, MN 55108**

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