ACS Reform of Introductory Science courses for Non-Majors Course Mini-grants
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***HIV/AIDS: Development of a Thematic Non-Majors Biology Course***

## Summary

This proposal outlines the design and implementation of a new course for non-majors in the Department of Biology at Davidson College. The proposed course differs from traditional non-majors biology courses in two significant respects. First, this proposed course will use HIV/AIDS as a central paradigm for the investigation of biology. By focusing on HIV/AIDS, students will be exposed to basic concepts within the context of a current public health problem. This focus will facilitate the engaged learning of the students. Second, this proposed course will include a combination of standard lecture sessions and small group discussion sessions. Upper level biology students who have taken an advanced seminar on HIV/AIDS will serve as preceptors for these discussion sessions. By utilizing this model, we will be able introduce conceptually difficult information to a large group of students during the lecture sessions and allow students to discuss more theoretical issues in small groups.

As described more fully in the Project Description, this course has four main educational objectives. First, students should increase their understanding of biology. Second, students should better understand the inter-relationships between scientific disciplines. Third, students should understand the scientific process. Fourth, students should improve their ability to critically analyze and interpret data.

For students enrolled in this course, the desired outcomes will include advancements in both their knowledge and their skills. Advancements in knowledge will involve the acquisition of specific information about biology. Advancements in skills will include 1) a better understanding of the scientific process, 2) an increased ability to critically analyze data, and 3) improved oral and written communication skills. By achieving these outcomes, the students will be more scientifically literate and possess a better understanding of science as a process.

## Project Description

Since the first scientific reports of what is now known as AIDS were published in 1981, our understanding of HIV/AIDS has increased dramatically. Today, a wealth of detailed information is available about HIV/AIDS, both in the scientific literature and in the popular media. This information can be used, not surprisingly, to teach students a great deal about HIV/AIDS, specifically, and virology and viral pathogenesis, more generally. Similarly, a course focused on HIV/AIDS could be used to teach undergraduate students introductory biology. By using HIV/AIDS as a central paradigm, basic concepts in biology can be introduced to students within the framework of a real world problem. This use of context-specific learning (1) or a "presenting problem" (2) has been postulated to facilitate engaged learning. Furthermore, one can use HIV/AIDS to illustrate not only specific information about biology,

but also to demonstrate the inter-relationships between scientific disciplines. Additionally, by examining the HIV/AIDS literature, students in a non-majors biology class will better understand the scientific process. Finally, a course focused on HIV/AIDS will allow students to improve their ability to analyze data and make informed, rational judgments based on these analyses. Thus, by using HIV/AIDS as a central theme within a non-majors biology course, students will gain a good understanding of biology. More importantly, especially within the context of a liberal arts institution, such a biology course can be used to improve the analytical and critical thinking skills of the students.

Not surprisingly, an upper level biology course focused on HIV/AIDS can be an effective means of teaching students about HIV/AIDS, virology, and viral pathogenesis. BIO 361: The Biology of HIV/AIDS (www.bio.davidson.edu/people/dawessner/361HIV/index.html) is an upper level Biology course that I offer at Davidson College. During the semester, the major HIV/AIDS scientific papers and related articles from the popular press are read in a chronological fashion, thereby allowing the students to 1) examine the advances in our understanding of HIV/AIDS in the order in which they occurred, 2) learn about the advances in molecular biology techniques that occurred during this same time frame, and 3) learn about different aspects of virology within the context of a major pandemic. Students are evaluated based on class discussions, several written assignments, and a group project involving community outreach/education. This approach has proven to be a very effective means of teaching biology majors about this specific virus, virology in general, and molecular biology.

The success of this course, to some extend, can be measured by the awards, grants, publications, and presentations associated with it. This course has been selected for inclusion in the National Leadership Resource Database, a compendium of curricular materials related to HIV/AIDS organized by the Association of American Colleges and Universities. A previous grant from the Associated Colleges of the South led to the creation of a web site containing pop culture references to HIV/AIDS (www.bio.davidson.edu/projects/hiv/HIV/Index.htm). Students in this course have been co-authors on several publications related to HIV/AIDS pedagogy (3, 4) and one student was the co-presenter on a presentation on the usefulness of this course in teaching undergraduates about virology.

The general approach utilized in BIO 361, using HIV/AIDS as an organizing theme for the semester, I would argue, also can be used quite effectively to teach non-majors about important aspects of biology, the interdisciplinary nature of scientific research, and the scientific process. Furthermore, this course will allow students to improve their critical thinking skills. By using HIV/AIDS as a central paradigm, students will spend the semester studying a topic with which they have some prior knowledge and/or interest. Thus, the important biological concepts will be presented not in a vacuum, but, rather, within the context of a current, interesting scientific problem.

Quite easily, a study of HIV/AIDS can be used to introduce students to basic concepts in biology. In this proposed course, for instance, we initially will address the question: what is HIV? To answer this question, we will need to investigate the properties of life, the structure of cells, and the basics of metabolism. As we begin to more closely investigate the replication cycle of HIV, we will need to examine the properties of the cell membrane and associated integral membrane proteins. Clearly, then, this unit will expose students to the basic concepts of cell biology. In subsequent units, we will investigate other aspects of the virus, such as viral replication. This particular section, not surprisingly, will serve as an entrée into discussions of DNA replication, mitosis, and meiosis. Throughout the semester, then, we will explore the

wonders of biology. This exploration, though, will occur entirely within the framework of HIV/AIDS.

While learning important biological concepts within the framework of HIV/AIDS, students also will learn more general information about the inter-relationships between different scientific disciplines. For instance, as we investigate how HIV initially recognizes and enters a host cell, we will need to address basic issues of chemistry. To understand how the virus interacts with its host cell receptor, students will need to understand the differences between covalent and non-covalent interactions. And, as we investigate more thoroughly the role of various HIV co-receptor molecules, we will investigate how slight changes in the amino acid sequence of a polypeptide can affect the three dimensional structure of the protein, and how such changes in structure can alter the affinity of the receptor protein for the virus. Similarly, when we discuss the development of anti-retroviral drugs, we will emphasize the inter-play between biology and chemistry; our understanding of biological processes can lead to the rational development of drugs by chemists. Not only will the interaction between biology and chemistry be explored, but also the interaction between biology and mathematics will be addressed. Obviously, any type of data analysis involves mathematical analysis. More specifically, though, we will examine closely the role of mathematical modeling and computer simulations as we discuss the epidemiology of HIV/AIDS. Throughout the semester, then, we will continually emphasize the inter-relationships between biology and other scientific disciplines. Again, this exploration will occur within the framework of HIV/AIDS, thereby maintaining the engaged learning of the students.

In addition to emphasizing basic concepts in biology and the inter-relationship between biology and other disciplines, this course on HIV/AIDS also will allow students to investigate and more fully understand the process of science. By examining the HIV/AIDS pandemic in a chronological fashion, we will be able to look at the state of knowledge at a particular point in time, discuss what important questions needed to be addressed at that point in time, and then examine how researchers actually investigated those very questions. For instance, the work identifying the coreceptors for HIV provides a wonderful avenue for investigating the scientific process. Initially, it was observed that the addition of the main HIV receptor, CD4, to murine cells did not confer HIV susceptibility on these cells. Several possible explanations for this result, including the necessity of a human-specific accessory factor or, conversely, the presence of an inhibitory factor within murine cells, could be postulated. After discussing these opposed hypotheses, students can design experiments that would test the validity of each and, as a class, we can discuss the strengths and weaknesses of their proposals. Finally, students can examine the actually experiments done by researchers. This same approach can be used, obviously, for other topics encountered throughout the semester. In this manner, students will gain an appreciation for the scientific process and the hypothesis-driven mode of inquiry. For students in a non-majors course, this course objective, perhaps, is the most important one. Factual knowledge, most likely, will be forgotten. Hopefully, though, students will retain an appreciation of the scientific process.

Throughout the semester, a fourth major emphasis will be data analysis and evaluation. Again, this general goal will be accomplished through the specific examination of HIV/AIDS. Recently, for instance, very different interpretations of the efficacy of the AIDSVAX vaccine trial data were released by researchers involved with the human trials and outside reviewers of the data. After examining these data, students will be able to provide their own interpretations

and discuss how potential researcher biases can alter one's interpretation of data. Through activities such as this one, students will improve significantly their critical thinking skills.

As indicated throughout this proposal, this course will include a combination of lecture and group discussions. Conceptually difficult information will be reviewed in standard lecture formats. In contrast to most introductory courses, though, this course also will contain weekly discussion sessions. During these discussion periods, students will investigate, in depth, more theoretical issues, such as the inter-relationship between different scientific disciplines, experimental design, and data analysis. In these discussion sessions, students will gain a better understanding of the topics covered in the lecture periods. More importantly, students will improve greatly their oral communication skills. Such discussions will be effective only if the discussion groups contain relatively few students. To manage small group discussions, one or two Senior biology majors who took my upper level seminar on HIV/AIDS will serve as preceptors for the class, in a fashion similar to a model course offered elsewhere (5). Along with me, then, these students will lead the small group discussions. These preceptors will be expected to keep abreast of the material covered during the lectures and serve as discussion facilitators during the weekly discussion periods. In return for their services, these preceptors will receive an independent study credit from the Department of Biology. By using this model, we will be able to accommodate a large number of students in this class, yet conduct part of the class in a preceptorial fashion.

The development of this course will occur during the 2004-2005 academic year. During this time, I will be on sabbatical and not have any teaching obligations. During the fall of 2005, I will offer my seminar on HIV/AIDS for Junior and Senior biology majors. The proposed non-majors course, then, will be offered in the spring of 2006 or the fall of 2006. Subsequently, the upper level seminar and the non-majors course will be offered in alternate semesters so that an upper level student who has taken the advanced seminar can serve as a preceptor for this proposed course. We project that 30-40 students will be enrolled in this course each year. As indicated in the attached letter from Dr. Verna Case, the Department and Davidson College administration fully supports the addition of this course to our curriculum.

This course will benefit our department, the College, and our student body in several ways. Most notably, this proposed course will fulfill the College's core requirement for a course in the natural sciences. Traditionally, the biology courses intended to fulfill this requirement are maximally enrolled. By developing and offering a new course that fulfills this requirement, we should lessen the enrollment pressure that exists on these course. Also, this course may serve as an appealing entrée into biology for some students. It is quite possible that students with a non-science interest in HIV/AIDS, either from personal experiences with the disease or because of interests in the economic or political aspects of HIV/AIDS, could take this course and become more interested in the scientific process. Finally, and most importantly, this course will serve to educate a population at high risk for HIV infection. Several recent studies have shown that the incidence of HIV infections among college students is increasing, especially in the South. Clearly, this population needs to be better educated and/or more fully realize the importance of safer sexual practices. This course, unlike a traditional non-majors course, can achieve this important public health goal.

**Evaluation, Dissemination, and Continued Support**

To determine the efficacy of this course, several means of evaluation will be utilized. First, during the course of the semester, standard exams will be required. These exams will be

designed to test the knowledge base of the students, both in terms of specific knowledge about HIV/AIDS and more general knowledge about biology. Second, a series of assignments will be developed to examine the ability of students to critically evaluate data. Throughout the semester, for instance, students will be asked to write short review papers that critique newspaper articles related to HIV/AIDS. By examining these papers, I will be able to determine if the students develop a greater appreciation/understanding of the complexities of scientific research over the course of the semester. In the discussion sessions, also, we will note the development of the arguments presented by the individual students. Again, this evaluation will help us determine the scientific development of the students. As in all courses at Davidson, student evaluations of the course will be gathered and reviewed. These evaluations will allow us to understand how effective the students think the course is. Finally, the number of students who take this course and then take other biology courses will be determined. As mentioned previously, this course could serve as an entrée into biology for some students. By determining the number of students who take this course and then subsequently enroll in another biology course, we will be able to determine how effective this course is in exciting students about biology.

The results of this project will be disseminated in several ways. First, a web site devoted to this course will be developed. The format, readings, and assignments, then, will be freely available over the Internet. I also will provide the course URL to Associated Colleges of the South schools either directly or through the ACS. After the course has been offered, I will present our results at a national meeting, such as the education session of the American Society for Microbiology annual meeting, the NABT national meeting, or an Associated Colleges of the South meeting. Furthermore, I will submit our results for publication to an appropriate biology education journal, such as the Journal of College Science Teaching or The American Biology Teacher. While this particular course will utilize HIV/AIDS as a central paradigm to teach introductory biology to non-major students, this model could be used quite effectively in a number of different disciplines. By widely disseminating information about this course, it is my hope that other faculty will 1) develop introductory courses focused on a specific issue, thereby increasing the amount of engaged learning that occurs within the classroom and 2) adopt the preceptor model discussed in this proposal, thereby increasing the feasibility of having small group discussions in an introductory course.

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