Department of Biology  
Futures Project Self-Study

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Introduction

Within the liberal arts there are many disciplines. Each of these, while focused on different topics, tends to operate in similar fashions. Each has its own language, which is taught to students in the early years of study. Each has a set of principles, upon which the discipline rests, and each engages in scholarship, which allows the discipline to thrive and develop. At some times we are more cognizant of the differences between one field and another, but most often we recognize that every field has the same basic premise, but is simply working with different aspects of the knowledge base.

In the liberal arts there is a commonality, yet there is also a diversity among the disciplines. Securely within this commonality is biology. The biological sciences are unique among the natural sciences, in that biology serves as a pivot from the physical sciences to the social and behavioral sciences. Indeed, given the rise of the biomedical sciences and the importance of the environmental sciences, an understanding of biology has become critical to all educated people. For this reason, biology provides an indispensable service for a liberal arts education.

As the twenty first century world now turns on biology, the result is that our graduates need not only to learn biological knowledge, but need an understanding of the principles of biology in order to be well prepared citizens of the world. They also need to learn how we know what we know about biology; in other words, they need to be able to discern how experiments are devised and interpreted to provide the knowledge we have.

Just as in 1900 a person well-educated in the liberal arts would focus on philosophy, so in 2000 the liberal arts education revolves around biology. Biology then serves as the crucial discipline for study, drawing in students from all areas to teach them how questions are formulated and answers divined so that they can make informed decisions as they go forth from here.

Westmont College in the 21st century needs to recognize the importance of biology to a well-educated person. A large part of today's society is aided and at times driven by biology (both biomedical and environmental studies). Biology, then, is in a unique position within the landscape of liberal arts disciplines. In part because we study life, we have become the only discipline that covers physics, chemistry, behavior, ethics, history, theology, . . . in our normal work. Indeed, this interdisciplinarity is a part of what we do as biologists and is a part of the role biology plays in the contemporary liberal arts. And because of this, biology is now the discipline in the pivotal position in the liberal arts.

Regarding the strength of our biology program, we have relied on anecdote and external data. The anecdotes are the emails from recent graduates who are now in professional programs or the workplace, and who inform us that their courses with us have well-prepared them for their positions. The external data are the success in acceptance to graduate programs. In the most
competitive case, our students are unusually successful in application to medical colleges, with 90% of biology majors who have earned a 3.4 average GPA or higher at Westmont, have received acceptance in their application to medical school in the past decade. While we are pleased with this, we are also seeking more comprehensive means to evaluate our education, and are considering requiring a comprehensive examination of our seniors prior to graduation. This would take the form of a one unit course in a student's last semester, and would allow us to assess both the individual students and our teaching.

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Standard - Active Societal and Intellectual Engagement

A. Current Strategies, Assessment, and Evidence

In our training, we seek to provide transferable skills to our students. These allow them to be better biologists both from the research skills they have learned and from the interpersonal skills they develop through our program.

Teamwork is a key aspect of our biology program. Starting with general biology laboratories, and progressing through the major courses and research projects, our students are compelled to work together to learn biological concepts through hands-on experimentation and observation. We also have an active summer research program that employs a number of students to work together on faculty-led research projects. In this program, our students work together to design and carry out experiments in biological research. Some of our challenges during these summer months are interpersonal dynamics among student researchers—they must learn how to work together because they are occupying the same laboratory space, working on the same project, with the same people, every day. They also must take responsibility for their own learning during this time because we faculty trust them to responsibly manage their time. We define the experiments and goals and allow the students to map out the best route to solve the problem. They must take it upon themselves to read the background literature as well as educate themselves about specific details of the experiments. In this way, we begin to treat our students in the way they are treated in graduate schools, engaged as partners in the search for understanding.

Our students engage a part of the world through directed volunteer work in the local community where they are able to expand their abilities and develop their potential professional interests. This work is via internships (Practicum), and through it they taste the professional fields of their interests, whether it be clinical, animal work, or botanical. These experiences have allowed a sharpening of desire for many, and fostered a redirection for others.

Our students also get a sense of community through involvement in the community of the biology department. From their first year on, we involve students by employing them as laboratory assistants, teaching assistants, tutors, and research assistants. They also become a part of the larger community through filling the constant need for biology tutors to high school students in Santa Barbara, and by participating as judges in local high school science fairs. Our students take part in the responsibility of daily life in the biology department and so learn how to be engaged in a community where learning and scholarship are central.

Our students get a sense of Christian vocation, both by example from faculty, and by direct discussions during academic advising. From early on, we encourage our students to keep attentive to what they like to do, to what they can do well, and to what needs to be done in the world. As they find matches among these things, they discover vocations.

We assess our success in this area by the outcomes of cooperative laboratories and research projects. In general, our students do well, as is evidenced by well-executed laboratory experiments and well-written laboratory reports. In the research area, student presentations at conferences and published papers provide evidence of their success in working together and taking responsibility for their learning. In the community area, we feel the evidence of our efforts is the close community that is a feature of the biology department. Our students have a sense of belonging to and participating in the biology department. They see their role in making the department what it is and therefore take personal pride in being a part of it.

B. Satisfaction
We have a high level of satisfaction in this area. A community of scholars, involving both students and faculty, has actually formed in our department. This is noted by our students along with the rest of the campus that sees the biology department, both students and faculty, as being actively involved in their intellectual pursuits through research, and actively engaged in the community through service.

C. Future outcomes and assessment.

To some extent, we have some satisfaction with our current activities, though we are concerned about the paucity of resources we now have for our students. It is our belief that the College needs to provide more resources. We are not being honest with our students when we have too few faculty in biology, too few research opportunities for our majors, and too few internships for them.

As an example of the numbers involved, we can look at the declared majors as recorded by the Registrar in the Fall semesters. If we group these data into three five-year blocks, we have late-80's (86-90), early 90's (91-95) and late 90's (96-99). Comparing across the natural sciences, we can note the number of majors and the number of faculty and the respective ratios (number of majors per faculty):

<table>
<thead>
<tr>
<th>Major</th>
<th>late 80's</th>
<th>early 90's</th>
<th>late 90's</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biology</td>
<td>24.4</td>
<td>36</td>
<td>75.75</td>
</tr>
<tr>
<td>Natural Sciences</td>
<td>60.2</td>
<td>80.4</td>
<td>123</td>
</tr>
<tr>
<td>Nat Sci - Biology</td>
<td>35.8</td>
<td>44.4</td>
<td>47.25</td>
</tr>
</tbody>
</table>

Ratio of majors/faculty:

<table>
<thead>
<tr>
<th>Major</th>
<th>late 80's</th>
<th>early 90's</th>
<th>late 90's</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biology</td>
<td>6.1</td>
<td>7.2</td>
<td>15.15</td>
</tr>
<tr>
<td>Natural Sciences</td>
<td>4.3</td>
<td>5.0</td>
<td>7.7</td>
</tr>
<tr>
<td>Nat Sci - Biology</td>
<td>3.6</td>
<td>4.0</td>
<td>4.3</td>
</tr>
</tbody>
</table>

It is clear that the natural sciences have seen a substantial increase in the number of majors per faculty, and that this increase is fully driven by the increase in biology. While in the late 80's biology majors were at a relative disadvantage in terms of access to professors compared with other natural science majors (6.1 vs. 3.6), they are now at an overwhelming disadvantage (nearly four-fold). It seems evident to us that to bring the biological sciences more into line with the rest of the sciences, several additional faculty are necessary.

Additionally, it is the opportunities for independent work that connects our graduates to the greater society, and prepares them for it. An example of this is the relative ease of job placement for those graduates who have engaged in summer research in biology here. In case after case, these students are either accepted into their first choice of professional school, or have been awarded well paying research positions. But this opportunity for summer research has become more limited as our major has grown. While a decade ago we typically had 2 or 3 summer research students and now we have 4 or 5, our major has gone from 10 graduates per year to 40. So the opportunity for summer research has gone from 25% to no more than 10%.
<table>
<thead>
<tr>
<th></th>
<th>biology faculty</th>
<th>lower division</th>
<th>upper division</th>
<th>graduates</th>
<th>% of grad. class</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>4</td>
<td>185</td>
<td>110</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>2000</td>
<td>5</td>
<td>210</td>
<td>250</td>
<td>44</td>
<td>14</td>
</tr>
</tbody>
</table>

The most striking points are the dramatic increase in upper division laboratory courses, which command a larger amount of faculty time, and the much higher retention of students in our courses to completion of the major, quadrupling the number of graduates.

It is critical to lay a foundation for students in research skills, as our society now depends on biological research and its dissemination. Our students learn that they can become part of this community of scholars, that they can become the person who solves biological problems for society.

Yet our ability to provide these opportunities has eroded as our student-faculty ratio in biology has tripled (from 10:4 to 40:5 using graduating majors for the counts) in the past decade. It would be advantageous for the College to bring us toward comparable levels with the rest of the natural sciences, where the comparable ratio is less than 2:1 (2 graduating students for each faculty member). In addition, in our non-majors and introductory courses we now have an average of over 50 students per class (range is 40-75). Until this is corrected with additional biology faculty, our graduates will have fewer opportunities than their peers in other disciplines.

To provide a good quality education and prepare our students with the skills needed to succeed in our society, we need the additional resources in faculty and research facilities.

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Standard - Critical Interdisciplinary Thinking

A. GENERAL COMMENTS

In attempting to reflect on the extent to which the instructional program in Biology helps students develop ability in critical-interdisciplinary thinking, it will help to begin with a definition of critical thinking as well as a survey of the types of instruction which occur in courses offered by the Department. Critical thinking has been described by Richard Paul (Think, April 1992, posted in the web site of the Foundation for Critical Thinking – www.criticalthinking.org) as “thinking about your thinking while you’re thinking in order to make your thinking better.” It involves disciplined reflection about the nature of a question being posed, the accuracy of information employed, the assumptions underlying an argument, and the logical relationships between information and arguments. It also requires attention to the frame or frames of reference in which a question is being examined – i.e., some questions will require an interdisciplinary approach. Implicit in the foregoing description, and made explicit by Paul in the Think article, is the understanding that critical thinking takes place in the context of problem solving, broadly conceived. According to Paul, “we think critically when we have at least one problem to solve...if there is no problem there is no point in thinking critically.” Although the term “problem” may be interpreted narrowly to denote a simple question for which a straightforward solution exists, we intend no such restriction in this discussion.

Instruction in the Biology Department is varied in its goals and in its strategies. Classes for students outside the Biology Department include both courses such as Human Anatomy which form part of the disciplinary training in another major and Introduction to Life Sciences, part of the general education of the College. Biology majors take classes which range from the introductory General Biology sequence to specialized upper division courses to integrative classes and seminars. In principle, all of the instruction through the spectrum of Biology Department offerings could be presented in a problem-solving mode which would lend itself to – even require – a critical thinking approach. After all, every “fact” in Biology was at one time an inference drawn from observations. This is impossible in practice, however, given the expectations of the biological community for the content of courses and the limited amount of time available in which to teach them. Accordingly, material is presented by Departmental faculty in a variety of ways, only some of which are designed to contribute directly to the development of competency in critical thinking.

B. SPECIFIC STUDENT LEARNING OUTCOMES – STRATEGIES FOR INSTRUCTION

1. Students are capable of exercising general critical thinking skills. Any time a student needs to do something with information, the opportunity to utilize and develop general critical thinking skills exists. In Biology courses, these opportunities include homework problems and higher order questions on exams, written work which involves a review of the literature for a particular topic, and class discussions. One particularly helpful exercise in developing critical thinking skills comes in the second semester of our General Biology sequence. As a culmination to their unit on evolutionary theory, the students prepare for and engage in a series of debates. The issues in contention are challenges to evolutionary interpretations of earth history which have been brought by scientific creationists – e.g., the age of the earth or the interpretation of the fossil record. Literature from both scientific creationists and evolutionary biologists is made available to the students, and they work as teams to prepare...
arguments for and against one of the scientific creationist challenges. Which position they will need to defend is a matter of chance, necessitating their thinking through the strengths and weakness of both sides and their preparing to argue persuasively for both positions.

2. **Students are capable of critical thinking in a wide range of disciplines.** The major contribution made by the Biology Department in meeting this goal for individual students is to provide instruction and practice in the scientific method while counting on other departments in the College to be similarly involved in training students in their own intellectual approaches. Sections dealing with the philosophy of science are included in both introductory and upper division courses, and, as seems appropriate, the historical development of biological ideas is presented along with their mechanistic explanations.

   Perhaps the most important aspect of critical thinking in the sciences is being able to draw theoretical inferences from experimental observations. In lecture courses, this is approached by presenting classic experiments in the field and by discussing the types of experiments one can perform to gain information about a biological process and the ways in which data obtained in those experiments can be analyzed. Homework problems provide practice for students in making the connection between experimental results and the concepts they are learning, and it is common to include questions on examinations that ask students to interpret experimental results. The senior seminar course, *Seminar in Biological Literature*, provides opportunities for students to read and critique the primary literature in Biology.

   Of course, it is in the laboratory that students gain personal experience in experimental design and data interpretation. All of the majors' disciplinary courses in the Department have weekly laboratory sections, and opportunities exist for students to be involved in independent research projects, both during the school year and during the summer. The laboratory sections of our courses provide opportunities to learn experimental approaches associated with the various subdisciplines in Biology, and in some courses, both at the introductory and upper division levels, students develop a research question of their own and design and implement an experimental program to answer it. An introduction to using statistical analysis in data interpretation is an important component of some upper division courses, particularly *Ecology* and *Genetics*, and in all cases, the students present the results of their work in the form of papers, posters, or oral presentations.

   Since only two of our non-majors' courses (*Human Anatomy* and *Human Physiology*) have laboratory sections, opportunities for students outside the sciences to develop facility with the scientific approach are much more limited. Indeed, it seems unlikely that a person will develop a “feel” for the nature of science and for the issues involved in critical thinking in this area apart from the personal experience of collecting data and trying to figure out what they mean. At this time, however, the limited number of faculty and a shortage of laboratory space in the Department preclude expanding the experiential component of our non-majors' instruction.

3. **Students are capable of complex problem solving involving more than one form of critical thinking.** The extent to which interdisciplinary thinking is emphasized in the Department at this time varies from course to course, depending on the nature of the material and on the interests and background of the instructor. However, three courses in the curriculum are specifically designed to promote this type of learning – *Seminar in Bioethics, Biology and"
Faith, and Biology, Values and the Third World, the last course being offered as part of an off-campus program in tropical ecology. All three courses ask the students to think about questions which have both a scientific and a philosophical or social dimension through individual study and class discussion. Their work culminates in writing a paper, engaging in a debate, preparing a case study to be used in class, and/or making an oral presentation. Completing these projects necessarily involves critical thinking in relation to both dimensions of the particular issues.

4. **Students are capable of collaborating with people in other fields in order to solve problems and make decisions.** Although there have been points of contact with other departments, most notably with Marilyn McEntyre in English, there is, at present, no systematic attempt to address this outcome in the Department. One could imagine taking the three integrative courses mentioned in the previous section as starting points for developing interdepartmental courses which would involve both faculty and students from different divisions of the College, but this possibility has yet to be explored.

5. **Students recognize the limits of critical thinking in the search for truth and wise behavior.** Given the tremendous impact of science on the world views of our culture, having students understand the limitations of science is a major goal for us in discussing the philosophy of science. As mentioned above, these issues are discussed at the introductory level for both majors and non-majors and in certain upper division disciplinary courses as well. It is also one of the major topics in the integrative course Biology and Faith.

6. **Students are able to think critically with the appropriate attitudes.** We do not have an explicit strategy for addressing this outcome beyond simply modeling these attitudes in our own thinking as we teach and interact with students outside the classroom. Although we have no direct access to students’ attitudes, of course, we can observe the basic tone of their work, whether presented orally or in writing.

C. **ASSESSMENT**

In thinking about the assessment of critical—interdisciplinary thinking in Biology, it will be helpful to begin with a general observation. Even though there are many components of our courses which promote critical thinking, as described above, developing critical thinking skills per se in our students has been more of an implicit than an explicit goal. Of course, we want them to be good thinkers, but that is more of a background expectation than a goal for which we have a systematic learning program. Similarly, ability in critical thinking, either in the context of disciplinary work or in interdisciplinary studies, always plays a role in the assessment of student work, but there is never a separate “critical thinking grade” assigned. Although the Department is well satisfied with this approach, it may be that a more distinct evaluation of students’ critical thinking abilities may be desirable from an institutional standpoint. For our majors, one approach might be to include a laboratory exercise in the introductory General Biology sequence which introduces students to the activities and standards associated with critical thinking. This would provide the foundation for a more explicit evaluation of their critical thinking skills, and if this were coupled with students developing a portfolio of their work over the four years, it would be possible to look for improvement in their critical thinking abilities through their time in the College.

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Standard - Christian Orientation

A. Current Strategies, Assessment, and Evidence

Westmont College is a liberal arts institution in the Christian evangelical tradition. To that end, it strives to incorporate the Christian perspective in educating its students. Thus this first standard must be foremost in all the academic departments within the college, including biology. And so it is. The biology faculty is indeed composed of professing Christians, who attempt to follow Christ in our daily lives. Christ rules preeminently not only in our personal lives but also in our professional lives. This commitment to Christ is the basis of the professional activities of the biology faculty. Although there is no official strategy in the biology department concerning Christian orientation, at all times do we strive to give glory and honor to Christ in our teaching and research. By doing such, we strive to model the Christian-scholarly life for our students. A life that is dedicated to investigating the living creation and sharing those investigations with others, both here at Westmont and around the world.

There is one official course taught by the department on the biology and faith. This course has been well attended, and introduces students to the basic issues concerning the intersection of biology and the Christian faith. Although the biology department does not have an official position concerning the issue of creation and evolution, there are several courses in which the issue is addressed. These courses include the non-majors course Origins (Bio 31) and the majors course in general biology (Bio 6). The purpose of these courses is to assist the student with the various positions taken to the creation-evolution issue. It must be noted that at no time is the doctrine of creation undermined in these courses by the departmental faculty.

Assessing the success (or failure) of the current strategy is difficult, since there is no formal system for evaluating the effect of the biology faculty's Christian orientation in terms of our profession.

B. Satisfaction

Although these is no formal means to assess the impact of the biology faculty's Christian orientation on students, antidotal evidence suggests that students do appreciate our efforts to model professional lives dedicated to Christ and to discuss candidly issues concerning biology and religious faith. Time and again, each of us receives cards and letters thanking us for our efforts both within and without the classroom to model Christian lives.

C. Future Outcomes and Assessment

Although there is no official strategy instituted by the biology faculty to implement a Christian orientation in the department, there is no need to do such. The courses that are offered by the department on issues concerning biology and faith are more than adequate to meet the needs of the students. Moreover, the modeling of every biology faculty member of the Christian life serves not only to confirm the teachings of the classroom but to extend those teachings.

Although no changes are needed in terms of future outcomes, there is needed some means by which to assess the efficacy of the current attempts of the biology faculty to provide for our students a Christian orientation to our discipline. The best means may be devise a questionnaire to poll graduating seniors as to how effectively the biology faculty is presenting a Christian orientation to the discipline. From such information we might be able to identify problems that need to be redressed, as well as to continue those devices in place that are working.

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Standard - Written and Oral Communication

Student Learning Outcomes

Students working within the discipline of Biology need to be able to communicate effectively with others in the dissemination of information, that which they themselves have generated or that which has been generated by someone else in the field. In order to be fully competent in communication skills, relaying information to others is only one half of the equation. As well, students of Biology need to be able to read and understand the work of others, and then assess interpretations of that work, be it that person’s or their own. In the Biology Department, we encourage and work closely with students to develop the skills necessary to communicate effectively, both in the area of generating information but also in the ability to assess information that is coming to them, be it in a lecture format, from a textbook or a primary literature source, or from an Internet source. Adequate development of this skill not only serves the students within the field of Biology, but also in every other aspect of their lives, where clear and effective communication, one to another, is vital and necessary in a very “information-oriented” world.

CURRENT STRATEGIES, ASSESSMENT AND EVIDENCE:

How do we in the Biology Department go about the task of helping our students to develop effective, and necessary, communication skills? We try to provide a very diverse set of opportunities for students to communicate, both in written format and orally. These opportunities begin very early on in the student’s exposure to Biology. In their first course (a lower division sequence), they are not only asked to relay information gleaned from lectures, their textbook and their lab experiments through exam and quiz formats, but as well, are asked to devise a simple experiment and then after conducting the experiment, relay their data in a poster format, knowing full well that faculty and other students will ask them questions about their project, and that they will need to be able to explain and clarify further what they did and why they did it. It is also at this early stage, that they begin to learn the technique of keeping a laboratory notebook, an “at the moment” record of their work, and as well, are asked to begin the task of learning how to review and summarize literature written in the field. A small, topic-oriented literature-search paper is the culmination of that task. In addition, one further opportunity is provided at this early stage in the form of the Creation-Evolution Debates, where the students are asked to review information presented by others representing both sides of the issue, and then the students are asked to present, in a advocacy style, the perspective of one of the two sides to the rest of their classmates (on a selected topic). Both the faculty involved with the course, and their fellow classmate, are asked to evaluate each of the student presentations. So, in effect, they are allowed to evaluate their own work and the work of each other. Thus, at an early stage in their development as practicing biologists, they are beginning to learn the techniques necessary to communicate effectively with others, in gathering and collecting clear data, in the written presentation of data and in the oral transmission of work that has been carried out.

Once they have progressed to the upper division level, many of their courses will require them to read primary literature, convey information in exam format, write, or present orally, proposals for independent projects, relay information and data on a project that they actually ran themselves in the form of a research paper, and conduct extensive literature reviews of work done by others and present that summation in written and/or oral formats. They are asked to think about work that has been done, about conclusions that have been drawn by others, under what context those conclusions...
were drawn, and to state, through both oral and written means, whether or not those conclusions are valid, and to state why they think so. Students enrolled in field courses must keep very detailed notes of all work done in the field, and to explain why data looks the way that it does and why they came to the conclusions that they did, knowing that field data changes with the nature of the setting, and the vagaries of weather, behavior of organisms being studied, etc.

In some courses, the students are asked to give a lecture to the rest of the class. This requires the student to fully read and understand the material, then prepare a clear and thorough presentation (notes, note cards, outlines, overhead transparencies or other forms of media presentation) and then actually give the lecture, not only presenting the information that they have gathered orally, but answering questions of the other students, either to clarify points that were not clear, or to expand on some point that was mentioned that needs deeper examination. These may be evaluated by the course faculty member or through peer review.

In all aspects, whether it be an essay exam, an oral presentation, poster presentation, written literature review, lab or field notebook, lab report, project proposal or completed research paper reviewing an independent project, the faculty are reading these with not only a critical eye as to the logic and clarity of the hypothesis and conclusions, but also with corrections and suggestions in mind that will help the student develop more effective communication, through use of language, grammar, terminology and to guide them into new ways of thinking, interpreting and assessing information. We are especially pleased to see new and creative ideas coming from our students, and we actively try to congratulate and encourage them to continue to do such good work.

A number of our students work on independent projects, either in the context of a course, or under the auspices of a research/practicum setting with one of the Biology faculty, either during the regular school term or during the summer. Often this results in data that is significant enough to be presented to others, outside of the department. Thus, these students are able to orally present their work in our Natural Sciences Seminar series here on campus, or to a larger audience at several of the state or national Undergraduate Research Conferences that are held each year, through either a poster session or at a regular lecture session. As well, some students choose to do Honors Projects, which culminate in both a major written paper, as well as an oral presentation.

Finally, many of our students work, either as Teaching Assistants or as Tutors, in both majors and non-majors courses in the department. They are asked to do a number of things, including some in-class instruction, usually in the laboratory for the course, lead study and review sessions outside of class time, and without the course instructor being present, and they may be asked to grade portions of exams, quizzes, lab reports or lab notebooks, and to include their comments, provide correct answers to questions missed, or to suggest ways that they themselves might have done the work to more clearly express an idea. Thus, we try to develop in students the ability to see different ways of doing things and expressing those ideas, and at the same time provide for them constructive criticism and the means to develop wise use of knowledge and for the relaying of suggestions as to how something might be better done.

All students, and certainly those going into biology, where information changes so rapidly and in part, is influenced by society at large, and where funding is not always readily available, must be able to read and understand, particularly that work that has already been done, thus giving them something of an historical awareness of where the discipline has been—the very heart of the
process in terms of where the scientist goes next in their own exploration, and to write and present orally in a clear and effective manner their own work and ideas. They will use these communication skills to request funding, in their completing of applications for programs, appointments and positions, in the interview process, in the presenting of new ideas and experimental procedures performed, just to name a few, to a wide array of people, both within the field of biology and without. All of the courses in the Biology Department thus have large written components to them and as well, often an oral component. Effective communication is an integral part of being a competent and effective biologist.

SATISFACTION:

It would appear that we are doing a fairly thorough job of providing a diverse set of both written and oral communication activities to help develop and enhance our students’ abilities to communicate at all levels and with many different groups of people. Certainly, the fact that many of our students who apply for either Medical or Graduate School programs are accepted, is testimony to the fact that they can communicate, as they had to write essays for admissions and in many instances, had to go through an interview process. A fair number of students, by attending Undergraduate Research Conferences, are able to practice their communication skills by sharing work and experiences with others in both formal and informal settings. Many take these communication skills into the greater Santa Barbara community and as well, to third world countries, such as through the Potter’s Clay Program and programs that deal with development and management of resources in developing countries, either during their time here as students or after graduation. Thus, they must not only be able to communicate with their peers and the faculty here at Westmont, but must also be able to communicate with care and clarity in dealing with those of other cultural or economic backgrounds. Even our own off-campus programs in biology (Mayterm Costa Rica experience or Au Sable Environmental Institute programs) expose students to others of different culture, or background and even different perspectives on the issue of Christian faith. It would seem that our students have ample opportunities to develop their communication skills.

FUTURE OUTCOMES AND ASSESSMENT:

While we have provided many scenarios for the development of quality communication skills in our students, are there yet things that we could do to further enhance those opportunities? It is certainly true that our students need to see the active development of these skills not only in themselves but in us, their faculty mentors and advisors. We in the Biology Department have thought of a number of avenues to help further develop skill in written and oral communication that we might put into practice.

One possibility would be to have each student retain works, both written and in other media forms (video, voice-tape, etc.), so as to develop a Portfolio of works done over their four years while here at Westmont. This would allow the students to see their development and growth (or the lack thereof) in written and oral communication skills and allow us as faculty, to monitor a particular student’s progress in this area.

Other possible components could be:
1. Having all seniors give an oral presentation to the faculty and the rest of the biology students on the extensive Literature Survey and Review that they do in the Senior Seminar classes.

2. Devise some sort of an exam that would focus on written and communication skills (and could as well test for development of critical thinking, etc). This exam could be administered at the beginning of their college career in the Biology Major and then again at the end just before they graduate.

Certainly, we must work more diligently at ways to get our students to read—not just textbooks, but other types of good literature as well. This would expose them more to the printed word and the ways in which others have used the written word to communicate. Some of us in the department are usually in the midst of reading something, be it a journal article, symposium, novel, literature review, commentary, etc. and if something in that reading has particularly struck us, we may read segments of that work to students in our classes if it has relevance or touches on some aspect of a topic we have been discussing. Our enthusiasm for something we have read may stimulate the students to go off and read more of it on their own. Students need to hear someone who has very effectively communicated an interesting idea well.

In addition, maybe we as a faculty need to provide students with more examples of our own writing. Some of us do engage in writing on a fairly regular and active basis, both professional scientific writing, but also along other lines, such as less scientific forms of prose as well as poetry. Along other lines, members of the department often will do the same lab that the students are doing along with them—setting up the same set of conditions, gathering the data—and then, the students can see each of us actively recording the data in our own field or lab notebooks, and can see how we verbally, in written form, assessed what we saw; how we have communicated the events. Something of a “learn by doing and showing by example” scenario.

In conclusion, we must continue to actively and creatively develop our courses so that our students have ample opportunities to express themselves in both written and oral form. We as faculty must always provide an atmosphere where students are free to express any idea or thought, without fear or reservation, knowing that they will receive caring but pertinent criticism, commentary, and encouragement to develop ideas further. Even some of the dialogues that we faculty have amongst ourselves should be seen by the students, so that they may see communication (for better or worse) in practice. We, as well, must continue to seek new venues and programs off campus for our students to become involved with so as to engage them in the business of being good biologists, effective communicators and active and caring Christians.

-EH
A. Current Strategies, Assessment, and Evidence

Diversity is an important issue for our culture, at the turn of the twenty-first century. America contains various ethnic and racial segments within its population that must coexist in harmony, if it is to continue to prosper in the next millennium. To this end, it is important for each member of our society to appreciate the values of other members of our society that differ from our own ethnic or racial heritage. The mission of Westmont College must include room within its curriculum to address the various cultural values that go to make up our society. Although the college attempts to educate its students about America’s various cultural values, there is currently very little in the way of formal preparation, i.e., courses, to help students reflect on the impact of social class, gender, ethnicity, culture, and historical moment on their beliefs, values, ideas, and practices as biologists. It might be argued by some whether such training is necessary -- or possible -- for a natural science, like biology. Traditionally the natural sciences are supposed to transcend culture, ethnicity, or gender. Postmodern studies, however, have demonstrated that this position is naïve and misleading and that the natural sciences are culturally and socially bounded.

Currently, the biology department does not have a very ethnically or racially diverse student or faculty population. With respect to biology majors, there is a good balance between the number of male and female students. However, the number of minority students does not adequately reflect the number of minority students in society. The biology faculty again is not adequately diverse in terms of gender, ethnicity or race. Currently the biology department has not developed any strategies for increasing the diversity of its students or faculty members.

B. Satisfaction

Efforts to enhance students’ appreciation for the impact of social class, gender, ethnicity, culture, and historical moment on their beliefs, values, ideas, and practices of biologists is currently left to the discretion of each faculty member. Individual faculty members do address these issues within the classroom, but only as need or opportunity arises. For example, issues surrounding conservation biology, especially in terms of developing versus industrial countries, are discussed in introductory courses. But no formal class is offered by the department to help the student work through these issues in a more systematic manner.

Although the diversity of students and faculty in the biology department does not reflect that found within our society or even within other departments of Westmont, there is a desire on the part of the department to enhance its diversity.

C. Future Outcomes and Assessment

If the natural sciences are bounded by culture, then it is important for the biology department to make a more conscious effort to train students to appreciate the influence such forces have on the practice of biology. Importantly this influence includes more than simple ethical application but also includes the epistemological and possibly the ontological dimensions of biology itself. We would recommend that a one-credit hour seminar course, to be offered with the two seminars already offered by the department, be instituted that addresses these issues concerning the impact of diversity on ways of knowing in biology. In addition, a series of introductory lectures offered in Bio 6 would also address these issues for those students being introduced to biology at Westmont.

Increasing ethnic diversity within the student population of biology majors and on the biology faculty is going to require certain incentives. For minority students, the college must be
committed to offering scholarships that cover the student tuition of minority students. In addition, we would recommend a mentoring program in which minority students are trained by a biology faculty member on an individual basis, especially within the laboratory. As for minority faculty members, the college must again provide major financial incentives to attract minority and women biologists. This must include a more competitive starting salary, given the high cost of living in Santa Barbara, as well as a substantial set-up fund that will support the person's research until a grant is obtained within the first five years. We would also recommend a reduced teaching load the first two years, to allow the person to focus on necessary career development and course preparation.

-JM
Standard - Technology

A. Current Strategies, Assessment, and Evidence

Contemporary biology is a discipline that is critically dependent upon technology. It is rare to find an active biologist who is not conversant on the latest computer hardware and software. Additionally, biologists learn to assemble a vast array of equipment to accomplish the tasks at hand. Indeed, in the previous score of years, the number of different items of equipment considered de rigueur for a standard biological sciences laboratory has nearly tripled. No longer is a simple microscope and clinical centrifuge sufficient. These have been replaced by confocal microscopes with computer-controlled imaging systems, tissue culture laboratories, polymerase chain reactors, and micro-centrifuges.

To best prepare our students for this reality, we ensure that they learn to use the basic equipment and software packages used in most biological laboratories, and that they are proficient with computers. We begin in the general biology course, teaching students how to graph and analyze data, and how to read and find papers. Upper division students use specialized equipment and software along with computer interfacing for data acquisition and experimental control. Assessment of this is direct. We assign work that requires successful use of these items and their successful completion of the work gives them credit.

Satisfaction

Given the rapidity of development in this area, it is probably dangerous to express anything more than moderate satisfaction with what we do. However, from what we hear from our students, our efforts are indeed preparing them for their work as they go on from here. We put a lot of time into this area, and it seems that our time helps compensate for any lack in the equipment we have available for the students.

So while we are satisfied with what we are doing, it is a dynamic satisfaction. We always see more that we can do, and we work hard to make more available for our students. As in many things, this is likely to remain an area where we put in an inordinate amount of energy to simply keep pace.

C. Future outcomes and assessment.

Much of biology today is done with the aid of computers and computerized equipment. Most data searches are done online and many journals are web-based. Additionally, we could improve our students’ competency in several ways with additional technology. Ideally, there should be a computer lab within the biology department where students have access to the computers for running equipment, searching databases, analyzing experimental data, and working on classroom assignments. The general biology laboratory could be equipped with networked computers and interface hardware and software for data acquisition, experimental control, and data analysis. All of our courses should have websites where students could access information (this is true only for about half our courses so far). These things are primarily done by certain faculty in our department, and the greatest limiting factor has been available time. It is unclear to us whether this could be improved with additional support staffing, as it seems that the faculty involved need to be directly engaged in the computer work as well. But we feel that some additional departmental support staff would aid in this endeavor.
Second, and of great importance, the entire field of bioinformatics is unrepresented at our College. This is a newer field (perhaps 15 years old), and combines computer technology with biological research data, finding means to search and retrieve relevant data for analysis. As the wealth of biological data has burgeoned, the field of bioinformatics has become vital. Indeed, this field has become one of the three most sought-after by biomedical and pharmaceutical companies in their hiring. To address this, we should at least offer a course in this area for our students, provide training for department faculty, and establish a workstation for this area.

-GA
## Appendix - Course Syllabi

<table>
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<tr>
<th>Number</th>
<th>Course Name</th>
<th>Instructor</th>
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<tbody>
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<td>NS 12</td>
<td>Introduction to Life Sciences</td>
<td>Horvath/Percival</td>
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<td>Percival/Marcum</td>
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