Report of the
CALS Life Sciences Distribution Requirement Task Force

Charge:

In June 2006, Dean Susan Henry established the CALS Life Sciences Distribution Task Force. At the first meeting, she presented the charge as follows (extracted from the June 2006 minutes). Note that throughout this report, we are distinguishing among three groups of students: 1) students majoring in Biological Sciences, 2) students not in Biological Sciences but in majors in the life sciences, and 3) students in the non life sciences.

> This task force interfaces the Plant Science Task Force and the Undergraduate Biological Science Curriculum Task Force. There are a large number of life sciences departments outside of what we refer to as the biological sciences departments. Students not majoring in biology, particularly those in the non life sciences (such as the social science majors), are restricted to a narrow set of biological science courses. Large sections of the current biological sciences courses are "unpalatable" for learning. Many students take introductory biology at other institutions. We could experiment by expanding the distribution requirements.
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> This task force consists of social sciences and life sciences faculty members. It does not include faculty from the biological sciences—they are in the other task forces. (Ron Hoy was added as a member after a few meetings because of his knowledge about new initiatives in the USA for introductory biology courses.) This committee should discuss what we want students to learn. Should a new course be created? Are there existing courses that are more applied that could be used as substitutes for introductory biology?

Membership:

Lisa Earle (Plant Breeding and Genetics)
Joe Francis (Development Sociology)
Ron Hoy (Neurobiology and Behavior)
George Hudler (Plant Pathology)
Katherine McComas (Communication)
Ed McLaughlin (Applied Economics and Management)
John Losey (Entomology)
Ian Merwin (Horticulture-Ithaca)
Peter Trowbridge (Landscape Architecture)
Mike Van Amburgh (Animal Science)
Don Viands (Office of Academic Programs) – Chair

Task Force Activities:
Since June 2006, this task force met almost monthly to discuss the problem, followed by brainstorming sessions and development of this proposal for solutions to the problems. In fall 2006, one meeting was devoted to hearing the experiences and views of a student focus group. This focus group was created by each of the faculty task force members inviting a student from their major, in addition to two students on the Dean's Student Advisory Council. This student group also was consulted occasionally by e-mail. Between meetings, the task force members gathered information from the web from other institutions, sought view points from faculty members in the social science departments about the type of courses needed, etc.

Assumptions:
For most non life sciences students, the courses that we require will be their last formal courses in the life sciences. Therefore, they should build upon high school biology, chemistry, and math experiences: extending and integrating these foundational sciences in the context of major life science topics and areas of knowledge at the college level.

Student Focus Group Viewpoints:
During this meeting, the 11 students were highly engaged in discussions about their experiences with introductory biological science courses and their opinions as to what new courses should be. In summary, especially the students from the non life sciences stated that the BIOG 109-110 series has an overwhelming amount of information in the lectures and readings, much more than needed for a student who is not particularly interested in biology. The work load is not too much, but nothing "clicked" because of too much information. These students agreed that biological concepts need to be tied into discussions about current issues, such as health care. The students from the Plant Sciences and Animal Science majors were not as critical about the current introductory biology courses and viewed them as worthy courses for students like them.

Task Force Conclusions:
Relevancy: Every task force meeting discussion revolved around the central theme that introductory biology courses for non life sciences students should present biological concepts in a relevant manner. As the students stated, concepts should be presented in the context of current, real world issues. The task force members were unanimous in this viewpoint, as well, and we recommend that this point be stressed strongly.

Katherine McComas consulted the faculty in her department (Communication) regarding what they thought courses should be. Below is an excerpt from one faculty member.

> "It's a course that would provide non-life science majors with a foundation enabling them to be savvy adult learners and participants in the public discourse, much of it involving some aspect of biology. Biology—in its many manifestations—is at the core of contemporary debates in medicine, politics, business, agriculture, trade, education and religion (this list could go on and on). I think it is crucial that students understand this.

> My objective, or criteria for success, would be that students have the interest and ability to probe into these debates and make judgments that are grounded in biophysical realities and constraints. I would want them to be able to make sense of the New York Times Science Section, and to have the motivation to read it. I would want them to notice and be able to make sense of the biological underpinnings and implications of news they read in other sections of the paper, or hear via other media. *E.g.,* in following the current discourse about stem cell research, I would hope that graduates of the introductory biology course could take a position based on their understanding of the science (and science ethics), rather than accept someone else's conclusion based on a religious or political position."

Communication students draw not so much on concepts, but on interrelationships of how people connect through technology and relationships with biology. Students do not necessarily need to memorize biological concepts. Understanding the scientific process is very relevant.

The appendix lists examples of issues that could be discussed while students learn biological concepts in courses. Courses could be developed around a single topic in similar manner as the first-year writing seminar courses.

Course Options:

Three categories of CALS students were discussed. Biological Science majors were not considered by this task force because the Undergraduate Biological Science Curriculum Task Force has been discussing them. Among the non biology majors are the other life sciences (Plant Sciences, Animal Science, Entomology, etc.) and the non life sciences (such as the social sciences majors). We concluded that the first category of non biology majors should take one of the current series of introductory biology courses (or those revised from the Undergraduate Biological Science Curriculum Task Force).

Our task force proposes that non life science students be provided with two options (menus) of courses to fulfill the distribution requirement of six credits of introductory biology. First, students who wish to complete one of the current series of introductory biology should be allowed to do so. The second option is for students to take courses that have the biological science concepts intertwined with real-world issues. These courses could be either current lower level courses in departments related to biology or new courses. The task force reviewed the current lower level courses in CALS (this list is available upon request) and concluded that several would be good candidates for non life sciences students, but all of these courses would need to be modified to include more biological concepts. Alternatively, new courses could be created. This option would be an opportunity for departments with low student enrollments to develop courses that would increase enrollments and better utilize teaching capacity.

The task force struggled with establishing guidelines for developing new courses, primarily with the issue of requirements of certain biological concepts vs. flexibility. The majority landed on the premise that "one size does not fit all"; therefore, there should be

flexibility in how instructors develop courses, regarding both the concepts and the pedagogy. These new teaching and learning models, while providing exciting and challenging pedagogical opportunities and innovations for both students and their instructors, pose administrative issues in terms of teaching loads as well as credit allotment, but overall should be viewed in terms of their potential to forge exciting new pedagogical ways for contextually relevant, research-oriented teaching.

Biological Concepts:
The task force agreed on the "less is more" principle, which agrees with the student focus group's assessment that too much material is covered in the current courses for students to absorb and remember. Below are some of the biological concepts that the task force listed as suggestions to be covered in courses, but not all would need to be covered in every course.

Biodiversity—What is it, how we study and classify it, and why it matters

Natural Selection—Evolution, speciation, extinction, etc.

Regional and Global Cycles—Carbon, nitrogen, water, and energy and their influence on climate, soil and water conservation, trophic hierarchies and interdependence, and human food and fiber systems

Cell Function—The Genome ← → Proteome ← → Metabolome

Physiology and ecology of Unicellular Organisms, Fungi, Plants, and Animals

These basic concepts can be conveyed and learned in various contexts and at various levels of complexity, within diverse life science disciplines. Faculty members should be encouraged to develop new courses where basic life science concepts interface with CALS disciplines such as economics, marketing, sociology, and communication.

Students should have many options to fulfill the CALS Life Sciences distribution requirements. Functional life science competency and awareness should be our primary objective, not mandatory exposure of all students to a standardized core biology curriculum. Repetition across courses was a concern, but we concluded that it is acceptable when presented in the context of various real world issues. These courses could be full-semester courses or partial semester modules. However, students would still be required to take at least six credits to fulfill the distribution requirement.

Pedagogy:
The task force emphasized pedagogy more than biological concepts. For students to think critically, we need to transform courses from passive note-taking to active instruction. Subject matter should not be simply covered, but students need to be active learners. Active learning is in contrast to the typical teaching described as "transferring information from the notes of the teacher to the notes of students without going through

the minds of either". Examples of active learning include problem-based learning, case studies, and peer instruction. In addition, the use of student response systems (clickers) in class is a means for instructors and students to actively dialogue and for instructors to receive immediate feedback as to the level of student understanding during class.

In addition, courses should have opportunities for experiential, hands-on learning. These experiences could be in the form of labs, field experiences, library research, etc. However, the task force does not think that there needs to be a lab every week of the semester; it could be as few as three per course. Again, flexibility in course pedagogy is emphasized to create courses with different "flavors" because of the diverse needs of the students.

In higher education workshops across the USA, team teaching of interdisciplinary courses is being emphasized. Team teaching would fit very well into the courses that we are proposing. However, the most effective team teaching is not done sequentially, but when all the instructors are present for every class session to contribute their perspectives from their own disciplines. We realize this type of teaching takes effort to accomplish effectively, and administrative support is encouraged to appropriately recognize these efforts.

Another model is to encourage teams including graduate students and post-docs to develop and teach courses. This experience would be very valuable preparation for a teaching career.

Class size is an important issue. The current introductory biology courses are too large for accomplishing the active learning and hands-on experiences that are described above. We recommend smaller class sizes of no more than 35 students. Obviously, with a third of CALS students in non life sciences majors, several courses would need to be developed or modified.

The university and administration should recognize that its call to the faculty to re-invent its curriculum, while an exciting prospect as well as challenge for the CALS faculty, could entail significant commitments in time investment for the faculty. Some of the recommendations toward the goal of creating a more relevant and attractive curriculum for CALS students who are not Biological Sciences majors could involve the application of pedagogical techniques as well as resources for implementing new courses. This is particularly true for ***interdisciplinary courses*** that involve faculty from more than one department.

We recommend that there be incentives to the faculty to commit themselves to new ways of teaching. Incentives could/should include course relief for the faculty to plan new courses, funds to purchase instructional materials, and support for faculty to attend workshops (held during summer months) to become trained in teaching techniques that are being implemented for teaching the "new biology". We note that at some of our peer institutions, incentives for innovative teaching include remuneration into faculty research accounts that could be used to support graduate students to attend national meetings, to

provide "rainy day" funds for use in faculty research, or to pay for professional books or research journals--all of which provide some welcome financial rewards in a time of diminishing research funding by external grant agencies. The timing for curriculum reform could be coupled with the University's capital campaign, which in part is meant to propel Cornell's research in life sciences into the top rank of research universities. The capital campaign would be made even more attractive if Cornell's alumni were made aware that the push for excellence extended to its undergraduate teaching as well as to its research programs. Among our peer research universities, there is now a national emphasis on improving undergraduate instruction in the sciences. An initiative to improve our life science teaching would seem to be an excellent goal for the CALS Development Office, and specifically targeting faculty incentives for developing innovative cross-disciplinary courses could be a win-win situation for all involved.

Course Proposals:

We recommend that a committee be established specifically to review and approve course proposals before they are reviewed by the CALS Curriculum Committee. Some of the members of this committee should be non life science faculty members. The courses should follow the criteria below.

1. Small class size (preferably 35 or less).
2. At least 33% of the contact time should be comprised of "active learning" (e.g., labs, discussions, field trips, case-based research/discussion).
3. Material should integrate across two or more biological concepts (primarily those listed above, although alternatives can be proposed).
4. Connections should be drawn between biological concepts and one or more pertinent topics (such as those listed in the appendix).

Faculty members who develop course proposals should attend the committee to present the proposals. This new type of requirement for the non life sciences students could be tried for a few years and evaluated for effectiveness, followed by modifications as appropriate.

Future Process

This proposal is intended to be presented to CALS administration and to other task forces and committee (Undergraduate Biological Science Curriculum Task Force, CALS Curriculum Committees, etc.), and other venues for discussion and possible revisions.

Appendix

Possible Topics/Issues for Intertwining With Introductory Biology Concepts

- Bioterrorism
- Biotechnology
- Emerging diseases: SARS, Avian flu, West Nile Virus, HIV/AIDS, Cancer, etc.
- The Biology of Food Choices
- Global warming
- Invasive species
- Biodiversity
- Evolution/Creationism
- Cloning
- Genomics
- Stem cells
- How humans make decisions on life-science related issues: is it rational or do brain and behavior issues arise? For example, there is a hybrid discipline called "neuroeconomics" that combines concepts from economics, psychology, and brain science.