CLUSTER I

Science

Biology

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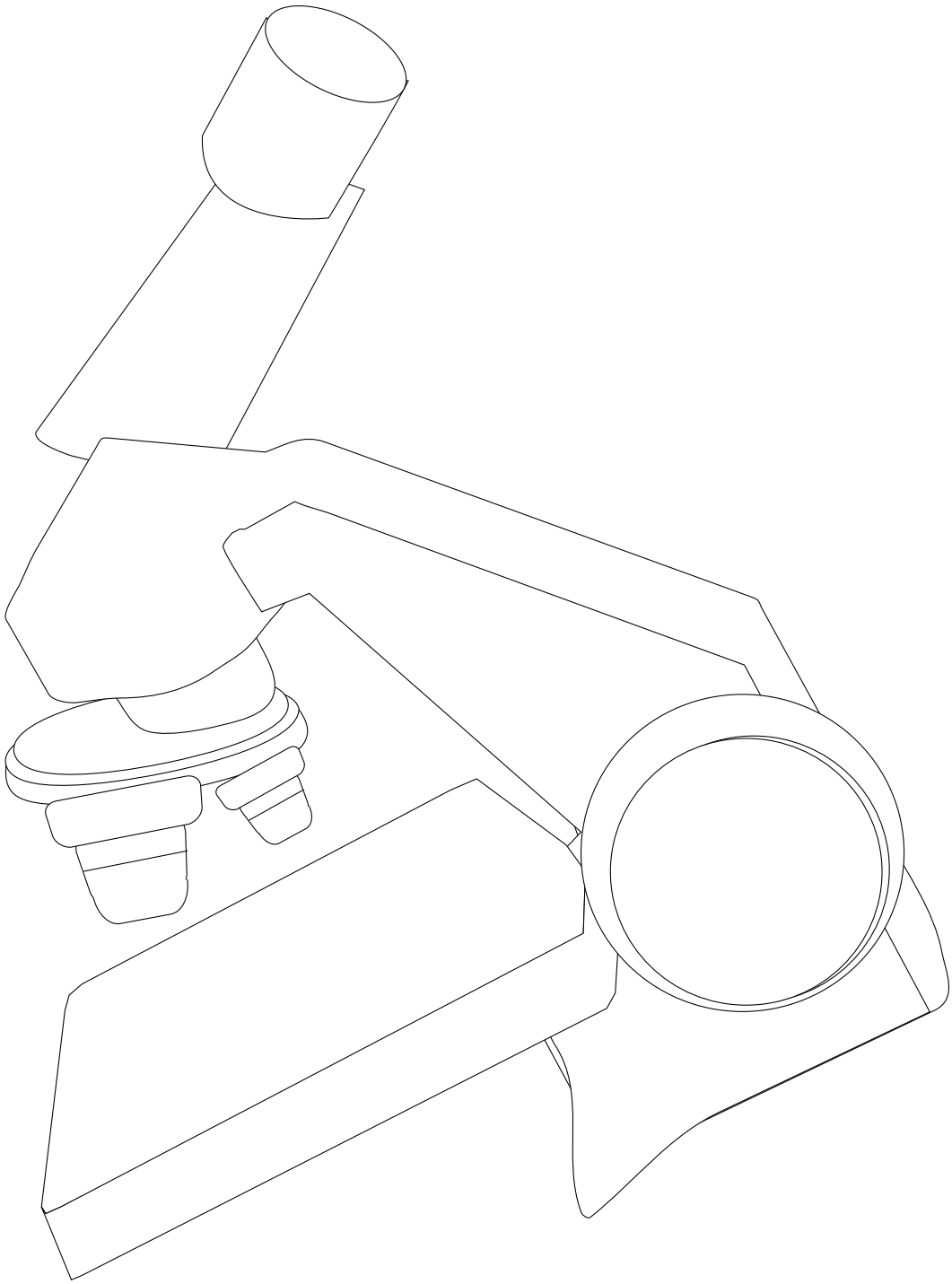

Summary of Identified Issues

The Biology groups at this year's regional and state meetings addressed two key proposals developed last year. We focused on refining the proposed core curriculum developed during the 2001-2002 meetings and detailed in Appendix 1. In addition, regional groups discussed in some detail a proposed lower-division GE transfer package for students majoring in the sciences (see Appendix 2). Five questions, generated at last year's meetings, provided a focus for our discussions. Background information, a summary of group responses, and general conclusions are provided for each question.

Question 1: Should the core curriculum be 2 or 3 semesters in length?

Question 2: Can we identify segments of the core for which Chemistry should be a prerequisite?

Question 3: Should the core have a minimum number of lab hours?

Question 4: Should the core have any defined lab components?

Question 5: How should we approach definition of an IGETC package?

Question 1. Should the core curriculum be 2 or 3 semesters in length?

Background

During last year's meetings, faculty developed a **proposed lower division core curriculum,** which included 25 topics and their proposed content. The question of core length was however not addressed. Whereas the core curriculum for Biology majors is two-semesters in length at a number of colleges/universities represented at those meetings, it is more than a year in length at about half the UCs and CSUs. (See Annual Report 2002, Biology, Appendix A at www.cal-impac.org).

Community College (CC) Responses

1. The lower division course load for Biology majors, including supporting science courses, is substantial. Therefore, some CC faculty prefer to maintain a two-semester sequence so as not to increase the course load further.
2. Some smaller CCs are restricted to a two-semester core primarily for financial reasons. Faculty from these schools have worked closely with their local UC and/or CSU campus to develop Biology core courses that minimize transfer problems for their students. For these CCs, a change to a three-semester core would be prohibited by cost and might disrupt transfer agreements that work well at the present time.
3. At some CCs, the majority of students transfer to a single UC or CSU. These colleges have designed a set of Biology core courses acceptable to the local transfer institution. For these CCs, alteration of existing courses to meet specifications of the proposed core might negatively impact their transfer students.
4. A number of faculty representatives felt strongly that topics in the proposed core curriculum could not be covered to their satisfaction in a two-semester (three-quarter) sequence. For these faculty, a three-semester core is preferable.

5. Some CCs have already extended their lower division core to three semesters or four quarters in order to cover topics in molecular biology or molecular genetics.
6. A three-semester core is preferable for many CCs in large metropolitan areas where students have a number of CSUs and UCs to which they can transfer. Whereas the longer core exceeds the requirements of many CSUs and UCs, students completing a longer core are less likely to have to take additional lower-division Biology courses after transfer, no matter which UC or CSU they chose.
7. Some faculty were concerned with unit equivalence among both CCs and transfer institutions. Many CCs presently teach a two-semester core sequence consisting of two 5-unit courses, each with 3 hours of lecture and 6 hours of lab per week. Would this be equivalent to three 4-units courses, each with 3 units of lecture and 3 hours of lab per week?
8. Other CC offer a two-semester core sequence consisting of two 5-unit courses, but each with 4 hours of lecture and 3 hours of lab per week. Would this be equivalent to three one-semester courses, each with 3 hours of lecture and 3 hours of lab per week?

CSU and UC Responses

1. The description of the core curriculum is seriously flawed with respect to the course units and hours of instruction. The description has not been altered in Appendix 1. Changes await further faculty input in subsequent years.
2. Of particular concern to UC and CSU faculty was the depth of coverage and rigor of the proposed core curriculum. The nature of such "rigor" may need more definition to be acceptable for transfer.
3. Although UC and CSU faculty stated that the proposed curriculum may exceed their institutions' core requirements, this was not necessarily a negative feature of the proposal. More education is not necessarily a bad thing, and might result in fewer transfer students having to take additional lower division courses after transfer and may ensure full preparation for upper division work .

General Conclusions

1. A 3-semester core sequence would transfer to more CSUs and UCs than a 2-semester sequence.
2. Although it would exceed the requirements of about half the CSUs and UCs, the additional intellectual development provided by a 3-semester core sequence is viewed more as a positive than a negative.
3. The definition of hours of lecture and lab needs to be more clearly stated than in the proposed core of Appendix 1.

4. Core topics may need to be defined more clearly in the future, perhaps with learning outcomes or expected competencies.

5. Schools with present, functional transfer agreements need not change their cores or transfers agreements to match the new core. The choice to do so will of course depend upon the functionality of the change for their transfer students and should weigh in current transfer agreements and patterns specific to each CC.

Question 2. Can we identify segments of the core for which Chemistry should be a prerequisite?

Background

At last year's meetings there was a general consensus that parts of the core curriculum should definitely require Chemistry as a prerequisite, but no effort was made to identify these particular components. At this year's meetings, the discussion clarified both the sections of the core that should require Chemistry as a prerequisite as well as the potential problems.

Community College Responses

1. Many CCs have created a set of core courses that allow students to study the macro-scale material (ecology, evolution, Organismal Biology) before they encounter the cell-molecular material. This strategy allows students to begin the Biology core without having first completed Chemistry.
2. Most CCs require Chemistry as a prerequisite for the cellular and molecular components of their core courses.
3. A few CCs do not require Chemistry for their Biology core, preferring to teach the necessary basics of Chemistry within the core program courses.
4. For some smaller CCs, non-majors can take core courses, which ensures sufficient enrollment. This strategy precludes a prerequisite of Chemistry.
5. Requiring Chemistry as a prerequisite for all core courses is a serious problem for CCs. This would be especially so if the core sequence without the additional Chemistry requirement is already three semesters in length. Such a requirement would preclude students from finishing the Biology core sequence in two years.
6. Many students enter Biology because of their fascination with animals or plants. Requiring a year of Chemistry prior to enrollment in a Biology course could have a discouraging effect on these students—reducing both the number of majors and enrollments.

UC and CSU Responses

1. Most UCs and CSUs require Chemistry as a prerequisite for the cellular and molecular components of their core programs.
2. Whereas many UCs and CSUs list the core course sequence with cell/molecular Biology as the initial course of the core sequence, it is becoming increasingly common that students are allowed to enroll in macro-scale courses without Chemistry and prior to enrollment in or completion of lower division core course that emphasize cellular-molecular concepts.
3. Although the lack of Chemistry as a prerequisite for ecology and Organismal Biology is not a problem for most CSUs and UCs, the absence of a Chemistry prerequisite for the cellular- molecular components of the core is a significant issue. There is serious concern among some UC and CSU faculty that cell-molecular components of the core taught to students who have not taken Chemistry might not be of sufficient rigor to properly prepare them for upper division courses.
4. Some CSUs and UCs require Chemistry as a prerequisite for all lower-division Biology core courses.

General Conclusions

A large majority of CSU, UC and CC faculty present at this year's meetings supported a Chemistry prerequisite for the molecular and cellular components of lower-division Biology core courses but not necessarily for courses that emphasize macro-components of the core. Many of these faculty did not seem to think it a particular problem for students to complete the macro-components of the core prior to the cellular-molecular components.

Question 3: Should the core have a minimum number of lab hours?

Background

Details of laboratory requirements for the lower-division Biology core did not receive much attention at last year's meetings. The subject of laboratory content was discussed only briefly and no recommendation was made concerning the amount of laboratory time that should be included in a core curriculum. An attempt is made in Appendix D of the 2001-2002 annual report to summarize lab requirements of CSU and UC lower-division core curricula.

Community College Responses

1. Most community colleges require at least one 3-hour-per-week laboratory session to accompany each 3-hour-per-week lecture course.
2. Many CCs that offer a 2-semester core require two 3-hour-per-week lab sessions to accompany each 3-hour-per-week lecture course.
3. A number of CCs that offer a 3-semester core sequence offer an associated cellular-molecular Biology laboratory as an option; but it is not required for completion of the core.
4. Most CC faculty had no difficulty with offering a 3-semester core, each semester to include a lecture course with an associated lab course.
5. The core sequence suggested in 4 above (3-semester core with corresponding labs to lecture courses) may pose a significant burden for some CCs, especially smaller schools with limited resources. This situation seems to apply particularly to lab courses with a heavy cellular-molecular emphasis. Some CCs may have to forego teaching the cellular-molecular lab course if a 3-semester core is implemented that contains a related lecture course, requiring their students to gain such experience after transfer.
6. Few, if any CCs will attempt to offer a core with four semesters of laboratory due to fiscal and physical plant restrictions. Most CC transfer students will need additional lower-division lab course work if they transfer to a CSU that requires this amount of lab work as part of their lower-division core. On the other hand, UCs expect students to gain the majority of lab experience during upper-division work. Thus, transfer students to UCs will not require the same level of additional lower-division lab course work after transfer.

CSU and UC Responses

1. Many UCs require only one or two quarters of lower-division lab; most lab experience is gained in upper division courses. For these UCs, a 2-semester lab sequence, each course consisting of one 3-hour-per-week lab session, would suffice.
2. Although many UCs presently require a minimal amount of lower-division lab experience, a number of UC faculty stated that their colleagues were considering a shift in philosophy that would increase this requirement to provide more lab experience prior to

initiation of upper-division coursework. This information should be considered when the transfer core lab requirements are decided.

3. A 2-semester lab sequence would also be sufficient for the CSUs that offer a 2-semester lower-division core sequence.
4. A 3-semester lab sequence, consisting of three courses each with one 3-hour-per-week lab session, would meet the lower-division core requirements of all but a few CSUs and UCs.
5. Several CSU and UC faculty stated that they have few concerns about the amount of lab experience of transfer students because of the extensive lab coursework already offered in association with lecture courses at CCs. Of greater concern to transfer institutions is the quality of lab work that transfer students complete (see below).

General Conclusions

Faculty at this year's meetings supported a 3-semester core sequence, with each semester consisting of a 3-hour-per-week lecture and an associated 3-hour-per-week lab. Although this extended lab requirement exceeds that of a number of UCs and CSUs, it would meet the lower-division core lab requirements of most UCs and CSUs. Those CCs with two 1-semester lab courses, each with 6 hours of lab per week, would meet the quantity requirement of the core, but would need to ensure that their lab courses included the appropriate cellular-molecular material. (See below.) The proposed core laboratory requirement would place a burden on smaller CCs whose students might have to transfer without completion of the cellular-molecular lab experience if facilities and funding are not available to help students satisfy the requirement. However, a number of these smaller CCs have already created articulation agreements with their primary transfer institutions that address this problem.

Question 4: Should the core have any defined lab components?

Background

A brief attempt was made at some of last year's meetings to discuss laboratory content. It was noted that actual lab content was often driven by facilities and budget, making it difficult to define lab content in a meaningful, coherent manner. The decision was made to address lab content at this year's meetings.

Community College Responses

1. Most CCs already offer sufficient laboratory coursework to meet the transfer requirements of most UCs and CSUs.
2. The largest problem at the present time is the nature and rigor of the cellular-molecular components of existing lab courses.
3. Many CCs have added extensive cellular-molecular components to their laboratory courses.
4. Smaller CCs may have a problem adding these components due to facilities or fiscal limitations.
5. A number of faculty reported efforts by administrators to shift to web-based or online lab courses, which would rely heavily on simulations and 'pencil-paper' labs.

CSU and UC Responses

1. The primary concern of UC and CSU faculty was that laboratory components of core courses contain certain key elements. First, exercises should be based on first-hand (primary) observations made during laboratory activities. Second, exercises should not be solely observational in nature, but emphasize data collection and analysis, and evaluation of laboratory results. In essence, the majority of lab work should be experimental.
2. Simulations clearly have a place within laboratory courses, but their role should be supplemental and not the primary elements of core laboratory courses.
3. The specific techniques used in laboratory exercises are less important in most cases than the application of those techniques in the collection and analysis of data.

General Conclusions

There seems to be general agreement that core laboratory courses should emphasize primary observation, techniques of data collection and analysis, and evaluation of experimental results. While observational laboratory exercises as well as computer simulations are acceptable and expected components of these courses, they should not form their essence.

Question 5: How should we approach definition of a IGETC package for science majors?

Background

At last year's IMPAC meetings, Peter Schiffman from UC Davis proposed adoption of an IGETC-like transfer package for science students (math, physics, chemistry, biology, geology). As viewed by faculty at a large number of CSUs and UCs, science students who transfer after completing IGETC or the CSU GE package, fail to adequately address the science core requirements and associated science courses for their major discipline. This situation arises either because they do not take all the necessary courses, or because the courses they took lacked the rigor required for their major discipline. As a result many students are prevented from enrolling in upper-division courses until they complete the prerequisites in math or Chemistry. Alternatively, students who complete the proper science courses, usually transfer without completing lower-division GE requirements. These students then are subject to the receiving institution's GE requirements, which in many instances delays time to graduation.

Problem

Develop a mechanism (transfer package) that would accomplish the following three objectives: 1) Clearly direct students to take prerequisite or associated science courses that are appropriate for their major discipline; 2) Defer by two courses the number of lower-division social science/humanities GE course required for transfer, to allow additional units for completion of major discipline preparation prior to transfer; and 3) Guarantee that transfer students need take only two additional lower-division GE courses after transfer instead on completing the entire GE package at the accepting institution.

The proposed GE transfer package is provided in Appendix 2 along with further background and an analysis of the components. As originally written, this proposal included units for each category or area. The way the units were originally presented created considerable confusion and in some cases inaccuracy. So the units were deleted from the proposal, to be included later by faculty in consultation with articulation officers who have the appropriate expertise.

Faculty Responses

1. It seemed clear from discussions at this year's meetings that the majority of faculty recognize the existence of the problem, as defined above, and a need to solve it.
2. One solution to this problem might be to highlight or footnote courses in the IGETC and CSU GE packages that are appropriate for science majors. However, a number of faculty commented that students do not consistently read footnotes or are easily confused when too many footnotes appear. Thus, this solution does not seem to address the problem in an acceptable manner.
3. A second possible solution is to remove all courses in the math and science categories that would be inappropriate for a science major—such as math for liberal arts. This approach would actually create a new document unless it was informally done as a way of directing science and engineering majors. However, counselors made the point that they do informally remove inappropriate courses when they counsel students, but this approach only solves the problem for students who seek counseling. Again, this approach does not seem to address the GE and units problem encountered by science students.
4. A third possible solution is to create a standardized science transfer degree (AA degree) that science students would complete prior to transfer. This degree would include the courses specific to math, science and engineering majors. However, this type of degree would have to be developed and approved locally by each granting institution, which would mean 108 possible variations of the degree. The outcome would not be a documented agreement between the three academic units (CCs, CSUs and UCs) and would not have the ICAS stamp of approval.
5. An IGETC-like transfer package could be approved through ICAS and then incorporated into an AA/AS degree so that any student completing the ICAS-approved science GE transfer package would also receive an AA/AS degree.

General Conclusions

The development of a GE transfer package for science majors would be of great benefit to science students, minimizing the time to graduation if they follow this plan. It would also be a positive development for CCs, CSUs and UCs, each of which would have to solve fewer problems created when students transfer without the proper preparation. A more comprehensive discussion of the proposal is presented in Appendix 2.

Identified Trends/Future Directions

1. Further discussions and minor alterations to the core curriculum proposal would provide minimal change in the context of IMPAC. Therefore, the core curriculum proposal presented in Appendix 1 should be distributed to faculty of the CCs, CSUs and UCs for analysis and response.
2. The responses of each segment should be used at next year's meetings to refine the final proposal.
3. The final proposal should be sent to CAN for approval by the end of next year.
4. Faculty from the three segments should continue to meet at least annually.
5. Future meetings should address the UC and CSU faculty concerns about the rigor with which topics are taught at CCs. Their concerns could be mitigated or addressed by more clearly defining content. This might be accomplished by stating the essential content

of each course (lecture and lab) in terms of learning outcomes, core competencies, or common experiences—what do the four-year institutions expect students to be able to do?

6. Future meetings should also address change in biological sciences that require an alteration of lower-division training. Changes in the lower-division core could then be instituted through the IMPAC and CAN processes.
7. The proposed GE package for science students (SciGETC) needs to be distributed to all segments of California higher education for evaluation and comment.
8. Future IMPAC meetings should focus on refinement of this proposal and merging the proposal with those from other science disciplines. The goal would be to have a final proposal readied for ICAS and segment approval by the end of next year, and institution of the proposal by Fall 2004.

Comments from Statewide Meetings and the General Field

Comments and concerns of community college faculty are numerous. First and foremost, CC faculty are teachers, interested in the intellectual development of their students. These faculty value the academic success of students both during their CC tenure and after transfer. With regard to post-CC success at CSUs and UCs, faculty are very concerned with creating a curriculum that provides the best possible preparation for transfer. To accomplish this goal, CC faculty need direct and continuous input from CSU and UC faculty. Without this input, their efforts to create an optimally transferable curriculum become a frustrating task rather than a directed exercise. This is particularly true with respect to the "rigor" expected by UC and CSU faculty.

CC faculty are also hopeful that the IMPAC process will result in a greater awareness by UCs and CSUs that changes in their curriculum have subsequent impact on CCs. Many examples of UCs and CSUs working closely with CCs do exist at the present time. However, the IMPAC process has made it clear that many UC and CSU faculty are unaware of the problems faced by CC faculty in the development and implementation of curricular changes.

CSU and UC faculty also consistently express a number of concerns. First among these is the degree of rigor with which courses are taught, clearly a legitimate concern. However, it would be extremely helpful if rigor was more accurately and completely defined. (This problem may be addressed by defining learning outcomes, core competencies, and common experiences at future meetings.) CSU and UC faculty are also concerned that laboratory preparation remain focused on primary observation, data collection and analysis, and evaluation. These lab skills are necessary for success in upper-division laboratory courses; they are essential if students are to understand experimental evidence that supports theoretical concepts presented in upper-division lecture courses. In addition, UC and CSU faculty stress that it is important that CC students transfer only after completing the core sequence at a CC. Students who transfer after completing only a portion of the core curriculum often have to retake core courses because the portion of subject matter completed does not match with the content of any core course taught at the receiving institution. Finally, it is important that transfer students complete the pre- and co-requisite science and math courses prior to transfer. Failure to do this often prevents students from taking upper-division courses immediately upon transfer.

Recommendations for the Discipline

Faculty attending the statewide meeting supported the following recommendations:

1. Disseminate the core curriculum proposal to CCs, CSUs and UCs for analysis and evaluation.
2. Refine and institute the core curriculum through the CAN process next year (2003-2004) for use in the 2004-2005 academic year.
3. Disseminate the proposed GE alternative for science students (SciGETC) to CC, CSU and UC faculty for evaluation and comment.
4. Refine and institute the GE alternative next year (2003-2004) for use in the 2004-2005 academic year.
5. Continue with IMPAC meetings for the purpose of defining the rigor and detail of core content, perhaps through development of learning outcomes, and updating the core content as necessary.

Comments from the Lead Discipline Faculty

The following observations derived from the last two years of experience with the IMPAC process.

Faculty from all three segments of public higher education in California (CCs, UCs and CSUs) are very interested in the goals of the IMPAC process and their potential positive effects on the success of transfer students. In spite of the extensive efforts of the IMPAC staff, information about the IMPAC process has not reached a good many key people who could transmit the information to teaching faculty. It is not clear to me why this situation exists, only that it does. When I have had the time to directly contact chairs or key faculty, the response has generally been rapid and very helpful.

The success of the IMPAC process depends heavily on input from CSUs and UCs. As the degree granting institutions, their faculty set the standards for transfer students. Without substantial input from these segments, CC faculty are developing curriculum without all the information necessary to create an optimally transferable set of courses. Whereas group meetings such as the regional and state IMPAC meetings provide positive outcomes such as the core curriculum and GE proposals, there is a great need to get this information in the hands of the UC and CSU faculty who make decisions about transferability of curriculum and can provide the necessary feedback.

It appears to me that personal contact, though very time consuming, is the most efficient way to accomplish this end. It would be most effective if the lead discipline faculty were provided time to visit with faculty at the various UCs and CSUs. Such visits could provide far more faculty feedback and encourage greater participation than is presently available. Information gathered at these meeting could then be brought to the statewide meeting for consideration. The result, in my opinion, would be a more rapid development of proposals and more efficient alteration of existing CAN courses and sequences.

During the IMPAC discussions, many issues have been raised vis-à-vis transfer courses, the proposed core, the GE proposal for science students, etc. But without data, it is difficult to assess the significance of these concerns. I have found a great need for data concerning transfer students. How many CC students transfer to each CSU and UC? What percentage of the upper- division students at each institution are transfer students? How many of these students

have not completed the necessary core preparation, or prerequisite and co-requisite courses? How do transfers students perform relative to students who enrolled at UCs and CSUs as freshmen? It seems obvious from my experience with the IMPAC process over the last two years that no single transfer curriculum (Intersegmental Major Preparation Articulated Curriculum) will meet the needs of every student. Accurate information about transfer students would help clarify the significance of any particular problem and the need to resolve it, locally, regionally, or statewide.

Recommendations for Support Courses

A lengthy discussion of the physics requirement for the baccalaureate degree in Biology occurred at the state meeting this year. Many UCs and CSUs require calculus-based physics to complete a degree in Biology, while others require a trigonometry-based physics. As a result, physics faculty must offer both a calculus-based and a trigonometry-based physics sequence to meet the needs of all of their students. In addition, they must offer a physics sequence for physics majors and engineers, which is very different from that offered for life science and other majors. The point made by some UC physics faculty during these discussions was that the sequence for physics majors and engineers was far more rigorous than either sequence offered to biologists, whereas the trig and calculus-based sequences were almost identical. Physics faculty felt that the differences between the two sequences for life science majors were so slight that there was no real need to have two sequences. The issue of limited difference yet varying requirements of UCs and CSUs also arises when CC counselors and faculty are directing Biology majors in their preparation for transfer.

There seems to be a serious need for physicists and biologists to discuss the essence of the physics requirement and the need for a calculus-based physics sequence for life science majors. This discussion will require total participation of UC and CSU faculty as they decide the BA/BA degree requirements.

Topics for Further Discussion

See Recommendations for the Discipline.

Recommendations Forwarded to be Forwarded to:

CAN

ASSIST

CIAC

The proposed core curriculum, as well as new CAN descriptors, should be forwarded to CAN in 2003-2004 for consideration following review of these proposals by CCC, CSU and UC faculty groups.

BIOLOGY CORE CURRICULUM

To Faculty of California Community Colleges, California State Universities, and Universities of California:

At last year's IMPAC meetings faculty expressed a strong interest in defining lower-division core requirements as a series of modules rather than a collection of courses. The primary focus at last year's IMPAC meetings was the completion of this goal. At this year's meetings, faculty attempted to add definition to this core by defining core length, lab hours and prerequisites. The results are presented on the following pages.

The following questions remain to be answered:

1. Should the core be described as one-year or three-semesters (four quarters) in length?
2. Should the lab component of the core be described as three hours/week per semester (or quarter) or in some other manner?
3. Which particular components of the core should require Chemistry as a prerequisite?
4. Should the core be described by a set of student outcomes rather than a list of Topics and Elements?

PROPOSED CAN BIOLOGY CORE CURRICULUM

The lower-division core curriculum for the biological sciences is defined by the following criteria. Any sequence of lower-division Biology courses that meet these criteria will be considered as equivalent to this core.

Hours of Lecture:	9 semester units (12 quarter units)
Hours of Laboratory:	3 semester units (4 quarter units) Pre-requisites: One semester inorganic chemistry for cell/ molecular elements of the core as defined in the core content Core Content: Equivalent to the Topics and Elements listed below.

NOTE: A semester or quarter lecture unit is defined as one hour of lecture per week for the length of the term. A semester or quarter laboratory hour is defined as three laboratory hours per week for the length of the term.

TOPIC/Element/ Content (with corresponding CAN course number)

1. DIVERSITY

A. Plant Diversity

plant system structure and function (CAN6)

systematics and taxonomy (CAN6)

phylogeny (CAN6)

B. Animal Diversity

animal system structure and function (CAN4)

systematics and taxonomy (CAN4)

phylogeny (CAN4)

homeostasis (CAN2)

development (CAN4)

behavior (CAN4)

C. Diversity of Viruses, Prokaryotes, Protista and Fungi

structure and function of Archaea, Bacteria (CAN2)

structure and function of protist groups (CAN4, CAN6)

structure and function of fungi (CAN6)

viruses (CAN2)

2. ECOLOGY and EVOLUTION

A. Population Ecology
   population structure, growth, regulation, fluctuations (CAN4)
   intraspecific interactions (CAN4)
   social systems and behavior (CAN4)
   physical environment as a selective force (CAN4,6)

B. Community Ecology
   interspecific interactions: predator-prey, competition, symbiosis (CAN6)
   community structure, regulation of community structure (CAN6)
   temporal change in community structure (CAN6)

C. Ecosystems
   energy flow (CAN6)
   nutrient cycling (CAN6)
   conservation biology

D. Molecular Evolution
   evolutionary change in nucleotide sequences
   rates and patterns of nucleotide substitution (min)
   molecular phylogeny (min)
   evolution by gene duplication, transposition (min)

E. Micro Evolution
   natural selection (CAN 4)
   alternate theories (CAN4)
   speciation (CAN4)

F. Macro Evolution
   speciation (CAN4)
   mutations rates
   evolutionary history
   extinction (CAN4)
   fossil record (CAN4)

4. GENETICS

A. Transmission Genetics (alternatively refers to Mendelian or Classical genetics)
   monohybrid inheritance patterns (CAN2)
   dihybrid inheritance patterns (CAN2)
   gene interactions
   sex-linked inheritance patterns (CAN2)

linkage, gene mapping

haploid genetics (min)

microbial genetics (min)

B. Population Genetics

changes in allelic frequencies (CAN4)

mechanisms of change (CAN4)

Hardy-Weinberg equilibrium model

C. Molecular Genetics (alternatively Molecular Biology)

DNA structure, synthesis, replication CAN2)

Gene structure (CAN2)

Gene expression: transcription, translation (CAN2)

Genome structure (CAN2)

Error and repair (CAN2)

Control of gene expression

5. CELL BIOLOGY

A. Structure and Function of prokaryotic and eukaryotic cells

Membranes: chemical composition, organization, biophysical properties, transport

Intracellular traffic: ER, golgi, protein synthesis and distribution, secretory pathways, endocytosis, lysosomes, cellular digestion, cytoskeleton (CAN2)

B. Cell Reproduction

simple cell division (mitosis), fission (CAN2)

cell cycle: variations and molecular control (CAN2)

sexual reproduction and meiosis (CAN2)

C. Cell Communication (Alternatively Cell Signaling)

receptors and signal transduction (CAN2)

D. Immunology (CAN2) optional or minimal

6. BIOCHEMISTRY

A. Phototrophic Energy Metabolism

photosynthesis (CAN2)

B. Chemotrophic Energy Metabolism

glycolysis (CAN2)

fermentation (CAN2)

aerobic respiration (CAN2)

alternative energy producing pathways (CAN2)

C. Molecular Structure

carbohydrates, lipids, proteins (CAN2)

D. Enzymes

kinetics

mechanisms of action (CAN2)

energetics (min)

controls (min)

E. Molecular Metabolism

synthesis, storage, and degradation of carbohydrates, lipids (CAN2) (min)
storage, and degradation of proteins (CAN2)(min)

SCIGETC PROPOSAL

Background

IGETC (Intersegmental General Education Transfer Curriculum) and the CSU GE Certification continue to be very beneficial to students who transfer from the California Community College System to a University of California or California State University campus. These students transfer with the knowledge that they have satisfied the lower division general education requirements for the BA or BS degree; they do not need to complete additional lower division GE courses at the CSU or UC to which they eventually transfer. However, community college science students (biology, chemistry, physics, geology/earth sciences) often encounter problems after transfer that can delay graduation by a year or more, whether or not they completed IGETC or its CSU equivalent.

Many CC science students choose to complete IGETC or the CSU GE transfer package but then fail to complete the prerequisite and co-requisite science and math courses for their major discipline. CC science students make the choice to complete one of these transfer packages in part because they are often not certain which four-year institution they will attend; they often consider several alternative choices. Faced with the varied general education and major discipline requirements at prospective transfer institutions, they often opt for the one sure choice provided by the counseling staff: IGETC or CSU GE Certification. However, the minimum requirements set forth in these GE transfer packages for math and sciences often meet none of the requirements for a typical science discipline. For instance, liberal arts math meets the GE requirements for most non-science majors and often no further math is required after transfer. But the math requirement for science disciplines is minimally a semester of calculus and more often a year. Thus, science students who complete a transfer GE package like IGETC might, and often do, transfer with math and science training that is inconsistent with major discipline requirements. These students must then complete the proper math and science requirements at the receiving institution. The result is a delay in their completion of major discipline courses that have as prerequisites the math and science courses they did not take prior to transfer.

Many CC science students are advised not to complete IGETC (or the CSU GE Certification) because of the problems discussed above. Students who opt to complete the correct math and science requirements in lieu of a GE transfer package face a different dilemma. If they choose not to complete a GE transfer package, they must then meet the GE requirements at the institution to which they transfer. This alternative often requires that the student complete a number of additional GE courses to satisfy the graduation requirements of their intended transfer institution. In addition, GE courses taken at the CC may not be applicable as GE courses at their chosen CSU or UC. Both these problems tend to increase time to graduation.

Finally, students who choose appropriate math and science courses and also complete a GE transfer package like IGETC, generally take more than70 units at their CC prior to transfer, which requires minimally two and half, and more often three years. With minimal residency of two years at the transfer institution, the time to graduation for these students is still five years or more.

Proposal

Faculty from UC Davis introduced an alternative to IGETC at the Fall 2001 regional IMPAC meetings. The proposal has been discussed for two years at regional IMPAC meetings and at last year's statewide IMPAC meeting, as well as at meetings of articulation officers. After considerable evaluation, it is perhaps time to proceed with a formal proposal through ICAS to CC, CSU and UC science faculty for evaluation and response.

The grid on the next page represents initial suggestions by science discipline faculty for an alternative to IGETC or the CSU GE transfer pattern. It sets forth a course of study that, if completed, will allow science students to transfer from a CC to most CSUs and UCs with two key goals accomplished. First, lower-division general education work will be accepted as equivalent to GE requirements at the receiving institution with the assurance that students will at most have to complete two additional lower-division GE courses. Second, it directs students toward completion of their major discipline coursework and prerequisite and co-requisite math and science courses. The left column of the proposal grid is the existing IGETC pattern; the right column is the alternative GE proposal, herein referred to as SciGETC. Because the majority of California Community Colleges operate on the semester system, the proposal is stated in semester units. The proposal includes four variations from existing GE transfer patterns that help students minimize the transfer problems cited in the background section and reduce time to graduation. These variations are summarized below with an analysis of each variance provided on the following pages.

1. The proposal is to defer the number of GE courses in IGETC Area 2 (Arts, Humanities, Social and Behavioral Sciences) by two. If these lower-division GE courses are deferred, they must be completed after transfer.
2. The proposed minimum math requirement is the first semester of the major's calculus sequence.
3. The minimum science requirement is changed to one year of Chemistry or physics or Biology depending on the individual major, or a combination of one semester of biological and one semester of physical science.
4. An additional row has been added to the bottom of the grid to highlight and emphasize the need for science students to complete the major preparation for their chosen discipline.

Note: The grid presented on the next page does not include units for each category, only a number of courses. Articulation officers with the expertise to ensure accuracy and minimize confusion should fill in the actual unit values.

IGETC (CSU GE)	SciGETC	Notes for SciGETC Students
Area 1 Written and Oral Composition UC 2 courses written CSU 3 courses 2 written, 1 speech	Same	
Area 2 Math/ quantitative reasoning 1 course	one semester of calculus for Biology majors 1 course	Many CSU and UC science programs require a year of calculus minimally; some require three semesters. Minimum preparation may cause you to take additional math before you can take upper- division courses in the major discipline.
Area 3 Arts and Humanities 3 courses including at least one from each	defer up to 1 course 2-3 courses	You must complete one additional lower-division GE course in this area after transfer. The transfer institution determines applicable GE courses.
Area 4 Social and Behavioral Sciences 3 courses from at least 2 disciplines	defer up to 1 course 2-3 courses	You must complete one additional lower-division GE course in this area after transfer. The transfer institution determines applicable GE courses.
Area 5 physical or biological 2 courses one with lab	1 yr of Inorganic Chemistry for Biology majors 2 courses OR 1 yr of calculus-based physics 2 courses OR CAN Biol Seq A 2 courses OR One life science and one physical science course including one lab course 7 units (2 courses)	Many programs require completion of calculus-based physics. Students are urged to review the discipline program requirements for prospective transfer schools. Biology students should focus on the CAN Chemistry sequence to fulfill this category.
Foreign language UC only 2 courses or 2 yrs HS	same 2 courses – UC only	
US History and Govern-ment - CSU only - 2 courses	same 2 Courses – CSU only	
39-44 units	33-44 units	
Lower-division course to be taken after transfer: none	Lower-division course to be taken after transfer: 2 courses maximally	

Major preparation is not required for certification but, where noted at right, completion of the major requirements prior to transfer is strongly recommended by the major discipline faculty.	IMPAC core 12-15 units (3-4 courses) plus additional math, Chemistry or Physics required by the major discipline. (It is strongly recommended that you complete these re-quirements prior to transfer.)	Biology students should complete the CAN core Biology curriculum plus prerequisite or co-requisite math, inorganic Chemistry, and organic Chemistry or Physics requirements before transfer.
Units including Major Preparation	60-72 units	These units include the pre- and corequisite math, Chemistry and/or Physics courses required for a typical Biology major.

Analysis and Comments

1. Title of alternative GE pattern

   The term SciGETC is used here for convenience. It is not a title mutually agreed on by science faculty. At least two additional names were offered. Some faculty felt the term SciGETC was too close to the existing IGETC pattern, which might confuse students. Other faculty thought the name SciGETC conveyed the parallel nature of the two patterns and would in fact be helpful to students.

2. Participating disciplines

   Biology, Geology/Earth Sciences, Chemistry, and Physics are the science disciplines listed in the background information. Discussions during the last two years also have included faculty in the disciplines of mathematics and engineering. The intent is not to preclude these disciplines from this proposal. They are not listed in the proposal because the IGETC transfer pattern seems to work fine for math majors, while the proposed SciGETC may not be functional for engineering majors.

3. Deferral of two lower-division GE courses until after transfer

   This provision allows science students to defer completion of two lower-division GE courses until after transfer. A key feature of this provision is that transfer students will need only to take two additional GE courses after transfer to complete the lower-division GE requirements for graduation. They will not be required to meet the GE requirements of the transfer institution beyond these two courses. The transfer institution, however, defines the applicable GE courses students may take to complete the deferred two course requirement. This provision allows science students to use the additional units to complete prerequisite or co-requisite science courses at the CC without accumulating an excessive number of units prior to transfer. In biological sciences, for example, students can use these units to complete a year of organic Chemistry or a year of Physics as required by the major discipline.

4. Minimum math requirement

   A one-year calculus sequence was the minimum math requirement in the original proposal. While many science programs do require a full year of calculus, some require

only a semester or two quarters. A single semester of calculus is stated as the minimum requirement in the present proposal.

As faculty review this requirement, please keep in mind the distinction between GE requirements and major discipline requirements. The idea behind the original SciGETC proposal was to direct science students toward completion of math and science requirements that met both GE and major discipline criteria and away from courses that were inappropriate for the major discipline. It was not the intent of the original proposal to supplant GE requirements with major discipline requirements, many of which may far exceed minimum GE requirements. Two criteria might apply to course selection for the math and science categories of this SciGETC proposal. The course(s) selected should meet the minimum category requirement and be compatible with major discipline requirements. One semester of calculus does not meet the major discipline math requirement for a large number of science programs. However, this course requirement does inform students that calculus is the minimum math course they should consider as meeting this GE requirement, and, it is compatible with requirements of nearly all disciplines in the sciences. Students might then be directed toward the one-year or three-semester sequence in adjacent notes.

5. Minimum science requirement

   UC campuses require two sequential science courses in the same discipline. For that reason, the minimum requirement for this category is set as a two-course majors sequence in Chemistry, Physics, or Biology. Chemistry and Physics students are directed toward a physical science sequence that also meets the major requirements, or toward the Biology sequence if required by their prospective transfer institutions. It also directs Biology students toward the Chemistry or Physics courses that meet prerequisite or co-requisite requirements for Biology. Alternatively, CSU students must complete one life science and one physical science course (one with a lab), which is the reason for the fourth choice offered in the category. This category should probably be accompanied by a set of brief notes directing students in each science discipline toward the appropriate choice. A possible example is offered.

6. Core curriculum requirements

   The IGETC transfer pattern does not include information about major discipline requirements. However, numerous problems encountered by science transfer students have convinced many science faculty of a need to make it clear to students that completion of the alternative SciGETC pattern still does not necessarily prepare students for transfer into the major discipline at particular institutions. For this reason, a row was added to the bottom of the grid to specifically direct students to the major core curriculum and to strongly suggest they complete the core before transferring to a CSU or UC. It may be preferable to provide this category with specific statements concerning the core curriculum for each discipline. A possible example of such a statement is provided.