Summary Report of the CSU Biology Workshop on Revising the Biology Major Core/Foundational Curricula – May 1-2, 2004

Thirty-four faculty representatives from 17 California State University (CSU) biology departments and a professional facilitator met for a day and a half at the CSU Fullerton Arboretum to exchange information about curricular reform in biology and to learn how to use current, research-based strategies to design new curricula. Prior to the meeting, department chairs and faculty participants were surveyed by email about what they hoped to learn and accomplish at the workshop and these results were used to develop the final agenda by a core planning team consisting of Joyce Ono (CSU Fullerton), Sue Elrod (Cal Poly San Luis Obispo), Nan Carnal (San Francisco State University), Tina Hartney (Cal Poly Pomona), and Elaine McClanahan, a professional facilitator (president, Strategic Learning). Elaine McClanahan had been involved in curricular transformations at CSU Fullerton and Cal Poly Pomona. This workshop was an outcome of discussions by the Biology Council, which consists of chairs and associate chairs from CSU biology departments throughout the state, to consider articulation issues with community colleges and to disseminate efforts of several departments that had revised their lower division, core or foundational curricula for biology majors.

Desired Outcomes for the Workshop

- An awareness of how campuses have revised their core/foundational curriculum for the biology major.
- An analysis of how to overcome some of the most common barriers to curricular reform.
- An agreed upon list of system-wide key concepts for foundational programs in the biology major.
- A process for developing student learning outcomes at the programmatic and course levels.
- Examples of innovative instructional strategies that are based on research and the incorporation of effective technology.
- Examples of assessments for selected student learning outcomes.
- An action plan.

Contents of the Resource Folder

Each participant was provided with the CSU Biology Workshop on Core/Foundational Curricula Revisions Resource Folder containing: the agenda, acknowledgments of the planning groups and financial support, a list of participants and their contact information, a summary of the responses from participants on expectations of the workshop, references for trends in curricular reform, responses to a survey about the nature of curricular changes, challenges to accomplishing revisions, and processes used to accomplish curricular reform from seven campuses that are undergoing or have undergone revisions of their core curriculum, instructions for each of the four breakout sessions and materials associated with each session, a matrix comparing the alignment of core/foundational course content from participating CSU campuses with the list of topics from IMPAC (Intersegmental Majors Preparation Articulated Curriculum, which is an attempt to develop a statewide core curriculum), summaries of 19 CSU biology core programs and syllabi for each of the core/foundational courses from the 19 CSU biology departments, a list of faculty presenting their innovative teaching/learning practices and assessments, a listing of faculty from throughout the CSU recognized by participants as being leaders in using effective and innovative instructional strategies, a working definition of student

learning outcomes (SLOs), Bloom's revised taxonomy, reference examples of SLOs and processes used to develop SLOs, summaries from the 1999 CSU Biology Assessment Workshop, a campus map and workshop evaluation form. A copy of the contents of this resource folder will also be provided to CSU campuses that did not participate in the workshop. Each campus was also provided with a copy of *Understanding by Design*, by Grant Wiggins and Jay McTighe, 2001, Prentice-Hall, Inc.

General processes conducted in each session

The facilitator, Elaine McClanahan, described processes that we would be using throughout the workshop to increase the efficiency and effectiveness of working together in teams. There were ground rules that would govern how we interacted to maintain efficiency and ensure productivity: "Everyone participates, no one dominates; one speaker at a time; help us stay on track; be an active listener; listen as an ally; keep an open mind." She created an "Issue Bin" on chart paper on which we were to post any issues, requests, observations, etc. that were not appropriate to spend time on during a particular session but important enough for all to consider. We would resolve these issues at the end of the workshop. All the products of each team were captured on flipchart sheets and on the computer for later dissemination as Group Memory. The Group Memory was disseminated to participants via email on June 10, 2004 and was also made available as a link to download at: http://biology.fullerton.edu/workshops/

Trends in Curricular Reform

Dr. Sue Elrod presented an overview of the basis for reform for biology curricula, many of these nationally recognized needs and considerations were cited as rationale for curricular revision by campuses that have undergone revisions of their curriculum or are planning for revisions (see below). In addition, advances in neuroscience and cognitive research are altering our understanding of how people learn and this has an impact on how we should be teaching. Surveys of first-year biology students indicate that many perceive their introduction to biology as memorization courses rather than courses where they 1) come to understand fundamental concepts in biology and can apply these and 2) gain more in-depth understanding of inquiry processes utilized by scientists to develop scientific knowledge. There are also pressures of accountability to the public that correlate with changing views of students and their parents of education as a product that they pay for, thus, there is increasing need for assessment of educational programs, especially with dwindling support for higher education. Dr. Elrod's presentation set the stage for considering how these national trends impact biology programs throughout the CSU.

Sharing how campuses have revised their core/foundational curriculum for the biology major.

The comprehensive resource folder (see content list above) contained descriptions from the seven campuses (Fullerton, Pomona, Los Angeles, Bakersfield, San Luis Obispo, San Diego, and Sonoma) that had undergone or were undergoing curricular revisions in response to a survey that requested these campuses to respond to the following questions: What were the driving forces for the change? Who was the driver? Who is/was involved in the revision, a few people

or the whole department? What revisions (i.e., in courses, infrastructure, instructional approaches, etc.) were made or are being planned? How does one get started—initial steps that you took or are taking? When did the revision process start? What kinds of timeline should one consider? What funds have been available to help with the revision and what are their sources? Do participating faculty have released time for design and development? What are the critical factors for success? What are the barriers? How were the barriers removed? What are the next steps? How did you handle articulation issues for transfer students? What processes, if any, are in place for ongoing improvements to the curriculum?

Three campuses, CSU Fullerton, Cal Poly Pomona, and CSU Los Angeles were selected to present their curricular reform processes. CSU Fullerton had used faculty collaboratives and the services of a professional facilitator, Elaine McClanahan, to effect their curricular reform, using the approach of "backwards design", i.e., identifying student learning outcomes (SLOs) first for the core courses. Dr. Joyce Ono, elected as vice-chair in 1998 served as the head of an ad hoc Curriculum Coordination Committee that oversaw the project and wrote grants to support the development of the four new core courses and to equip the laboratories. Two new faculty were hired in 2000 with expertise in curricular development. The department is committed to utilize active learning instructional strategies and inquiry-based laboratory and field experiences in their new core courses. Their new, four-course introductory curriculum was sequentially piloted starting in fall 2002 and all four courses were offered in spring 2003. Cal Poly Pomona developed an innovative foundational curriculum based on biological themes and the process utilized was spearheaded by Dr. Tina Hartney, who was hired originally to develop their non-major's curriculum, but had the expertise to lead faculty groups to articulate the goals and outcomes of the biology majors' foundational program first, followed by the development of a three-course introductory series. Pilots of these courses were implemented during the 2003-2004 academic year. CSU Los Angeles developed their new three-course sequence with faculty that had been teaching the current core courses and was an example of a campus that had not yet implemented their new curriculum and used more traditional processes for developing their new foundational courses.

Some commonalities were noted among the processes for revision among these seven campuses. Revision takes time, from 3-13 years. Revisions were accomplished by faculty groups, for the most part, without support for release time except for those in charge of coordinating the revisions, and communication about the new curriculum with the rest of the faculty was important and often accomplished by departmental retreats. Common drivers for change are: the ever-escalating amount of information in biology made the traditional, taxon-based core curriculum inadequate for representing biology, dissatisfaction with student performance in upper division courses, students still taking core courses in their senior year or taking them out of sequence, students today appear to be less prepared and lack the prerequisite skills and behaviors necessary for success in biology, thus leading to high numbers of failures in the foundational courses, problems with articulation with community colleges, feedback from accreditation bodies, program reviewers, or self-assessments administered by the department, influx of new faculty, and awareness of more effective ways of teaching.

Breakout session #1: Summary of barriers to curricular revisions and transformations

Faculty were divided into six teams consisting of representatives from different campuses and

asked to brainstorm the barriers to revising or reforming their core or foundational biology curriculum. They were then asked to prioritize and possibly consolidate or organize these barriers and identify the causes of their top one or two barriers. Once they had identified the roots of these barriers, they were asked to consider short term and long term actions to remove these barriers and to recommend the first step in removing the barriers with the highest priorities.

LACK OF RESOURCES: Time and Funding

Time

- Junior faculty have research as top priorities.
- Faculty are already overworked.
- Not everyone in a department is involved in sharing the responsibilities for change.

Causes:

- Mismatch between rewards and the time and efforts needed to plan and implement curriculum revisions.
- Departmental and administrative culture and long standing commitment to research activity as the prime basis for promotion in many biology departments.

Short-term actions:

- Seek release time, especially for junior faculty to develop new courses and instructional approaches or only have tenured faculty develop the new courses.
- Discuss retention, tenure, promotion issues in the department so the reward system correlates with the effort necessary to revise the curriculum.
- Increase efficiency to make the best use of time.

Recommended first step from various teams:

- Identify financial resources (external and internal) for release time buyout, for example, NSF-CCLI grants.
- Discuss retention, tenure, and promotion issues in the department.
- Increase efficiency by:
    - Finding ways to involve all faculty to spread the workload.
    - Hiring consultants to help with the process.
    - Finding out what others have done and share ideas with other campuses, (attend this conference).
    - Have faculty retreats during normal work hours to permit concentrated efforts necessary to effect curricular revisions.

Long-term actions:

- Revise the departmental personnel document to recognize the scholarship of teaching and learning in the departmental retention, tenure, and promotion processes so faculty are appropriately rewarded for the time and efforts spent in curriculum and course revisions and in faculty development.
- Recruit/hire faculty who have the expertise and desire to be involved in curricular revisions.
- Changes are required system-wide to decrease teaching loads for science faculty.

Funding

- Curricular revisions cost money because it requires expenditures to support faculty time,

faculty development, support staff time as well as the potential need for additional support staff, equipment, supplies, and facilities.
- CSU formulas do not support team-teaching of courses or the real cost of teaching laboratories.
- Administrative threats to departmental funding if there is a loss of FTEs.

Causes:
- Insufficient resource to support change.
- Administrative constraints in how resources are allocated beyond the departmental level.

Short-term actions:
- Seek extramural grant funds to obtain support for release time, equipment, and facilities refurbishment.

Recommended first steps:
- Identify financial resources (external and internal) for release time buyout, for example, NSF-CCLI grants.

Long-term actions:
- Alter resources management for the department to dollar-based budgeting or some other mechanism, which will allow the flexibility needed to fund team-teaching.
- Obtain financial resources from outside the department, VP for academic affairs, deans, provosts, chancellor's office.

RESISTANCE TO CHANGE
- Old school vs. new school, teacher-centered vs. student-centered cultures are not universally acknowledged or accepted.
- Engaging in curricular revisions is not usually part of faculty job description.

Causes:
- Fear of the new and unknown, loss of control of the familiar classroom and program structure, no one model is known to apply and work for all departments.
- Turf protection – fear that your subdiscipline or you will be marginalized.
- Faculty teach the way they were taught.
- Faculty want to do what they want to do and not have their academic freedom compromised.
- Fear of repercussions from negative student evaluations because initially, students do not like changes in the status quo.
- Lack of expertise in different pedagogical approaches; lack of time (or incentive) for learning and implementing these approaches; ignorance of change processes, or how to develop new curricula.
- Biology faculty do not regard cognitive research as "hard" or rigorous science and therefore have a bias against education research.
- Apathy and inertia, belief that the status quo is adequate.
- Lack of adequate data or awareness of data that change is warranted.

Short-term actions:

- Talk to other departments who have revised and reformed their curriculum.
- Get dean/chair to make change a priority.
- Faculty development:
    - Find an interpreter within the department to translate education and cognitive research terminology.
    - Find faculty within the department who can model teaching methods and have made changes in their individual courses.
    - Informal sharing of teaching ideas among faculty.
    - Use a facilitator to help effect change processes.

Recommended first steps from several teams:

- Identify why changes are needed:
    - Use exit surveys, consult advisory boards, and other forms of assessments available to evaluate the current curriculum.
    - Ask faculty what they want students to know in upper division courses.
- Find out what others have done, network (attend this conference).
- Begin to discuss the importance of non-traditional teaching modes in the department.
- Identify faculty within the department who can model teaching methods and have made changes in their courses; have faculty share their pedagogical successes among faculty.
- Establish student learning outcomes at the departmental level for the whole program.
- Increase buy-in of all faculty with retreat-like interactions.

Long term changes:

- Hire expertise needed to effect change:
    - Find or hire faculty whose responsibility will be to effect change and can model new teaching approaches.
    - Hire science education faculty.
    - Hire a facilitator who can develop processes for change.
- Develop a process for continual faculty development and a culture that supports this.
- Develop a departmental culture for continuous improvement of student learning and faculty participation in the process.
- Educate administrators about change.

OTHER BARRIERS THAT WERE CITED BUT NOT FULLY DISCUSSED

- Articulation with community colleges and how to integrate transfer students into a new curriculum.
- Student resistance to change.
- Lack of textbooks that support new instructional approaches or revised foundational biology programs.
- The need for team-teaching in courses that require integration of disciplines.
- Semester/quarter system differences: semester systems do not allow as much flexibility with different courses over time and quarter systems lead to narrower courses because of time constraints.
- Need for programmatic assessment and learning about assessment methodology.
- Need to consider “service” to other departments and programs when changing a lower division foundational program.
- Need for leadership in the department to effect change.

- Considerations of the student population in terms of their diversity, preparation for college work, math and technological literacy, reading and writing abilities.

Breakout Session #2: Sharing Current Course Designs

Faculty were divided into new teams with an attempt to group together faculty from campuses that were either on the semester or quarter plans to discuss and share their current core/foundational course designs. Some groups had members describe their core/foundational curriculum, others took a broader view and discussed issues common to their campuses. Several teams were asked to present their findings to the entire group, but all information was captured for later dissemination as Group Memory. Common issues that were identified are:

- Lack of continuity in building skills and content from sequential introductory courses.
- Determining the sequence order of foundational biology courses, which impacts the pre-requisites for the biology program. For example, chemistry pre-requisites for cell and molecular biology courses often force biology majors to take their foundational courses as sophomores rather than as freshmen if this course content is first in a sequence.
- Many introductory biology courses are also GE courses, which may limit the rigor of the courses if students that are less interested are enrolled and often presents problems about the level of the course and expectations of student achievements.
- Students do not appear to be adequately prepared for upper division courses.
- High failure rate in the first foundational or core courses is common.
- Some campuses have difficulty in enforcing pre-requisites for their courses whereas others have technology that flags students that lack the proper pre-requisites for courses they have enrolled in.
- Elements in the list of topics suggested as part of core curricula for biology majors by IMPAC do not include skills.
- Articulation with community college courses is a concern when revising foundational courses, as is how to involve community college colleagues in reform processes. Defining learning outcomes for introductory biology courses is important in facilitating articulation.
- The amount of time devoted to lecture and laboratory varies; laboratory time is more expensive.

Identifying Key Concepts in Biology

This session was introduced by a presentation by Dr. Sue Elrod on "Core Understandings in Biology", which explained the "backwards design" approach to developing curriculum and courses by identifying the desired outcomes first. The presentation was tied to the reference text that was provided to each campus, *Understanding by Design*, authored by Grant Wiggins and Jay McTighe. The hierarchical organization of outcomes, those that are worth being familiar with, those that are important to know, and "enduring" understanding was presented as concentric Venn diagrams, with "enduring" understanding at its core. Teams of faculty were asked to define what is meant by "understanding" and the relationship between understanding and knowledge and/or skills.

Breakout Session #3: Identifying the Big Ideas in Biology

The purpose of the breakout component of this session was for each of the six teams to identify the "big ideas" in the biology core/foundational curriculum. Team members

brainstormed big ideas or key concepts that should be part of the core/foundational programs in biology by listing a single key biological concept on a post-it note and posting it on flip chart paper. After all members had made contributions, any ideas that were unclear was clarified by the author of the posted concept. Following this discussion, team members grouped the post-its based on their similarities or affinities to each other and header cards describing each of the categories that emerged were posted. It was presumed that each of these header cards represented a "big idea" or major concept in biology that should be part of the core/foundational biology curriculum. These groupings and the contributions that led to the groupings were recorded on laptop computers available to each team. Explicit instructions were given to provide Joyce Ono with a listing of the major headings from each group so a compiled list could be created. This compiled list was then projected and the entire group voted for each of the list elements as being 1) acceptable, 2) acceptable with modifications, or 3) not acceptable, using the Personal Response System. The electronic system allowed instant feedback about the group's decision, projecting the percentages or numbers of votes for each of the three choices. Many elements of this compiled list were redundant or it was sometimes difficult to discern what was meant by a listing. The following list of "big ideas" were acceptable to at least 70% of those voting:
Mechanisms of Evolution (90.0%), Evolution and Genetic Change (90.0%), Cellular Basis of Life (89.7%), How Do Organisms, Populations, and Communities Respond to Their Environment? (87.1%), Biodiversity (86.7%), DNA to RNA to Protein (80.0%), Genetic Information Is Used to Direct Life Processes and Is Heritable (76.7%), Central Dogma and Molecular Biology (75.9%), Organismal Physiology (75.9%), Genetics (75.9%), How Do Genetics and Sex Lead to Inherited Traits? (74.2%), Molecular and Transmission Genetics (73.3%), How Do We Ask and Answer Questions in Science? (72.4%), Life Depends on Energy Transfer (71.0%), Energy Flow and Transformations (71.0%), Structure-function Relationships (70.0%).

During the evening, planning team members, Drs. Tina Hartney and Sue Elrod synthesized the "big ideas" generated by teams for which complete listings were available. They listed the header statements collected from each team that were used to develop a statement of a major biological concept or "big idea". The following is the list generated:

1) Life changes over time, leading to biodiversity.
2) Life depends on energy transformations and transfer.
3) Genetic information directs life processes and is heritable.
4) Life forms respond to and are affected by their environments.
5) Life exists as highly organized, complex entities.
6) How we ask and answer questions in science.

Informal Sharing: Innovative Teaching/Learning Practices and Assessments

After dinner, a relatively small number of participants attended a session, conducted by Dr. Nan Carnal (San Francisco State University), that showcased innovative assessments of specific learning goals or pedagogical approaches. Dr. Merri Lynn Casem from CSU Fullerton presented "Just-in-Time-Assessment: Using the Personal Response System (PRS) as a Tool for Learning in Large Classes". She demonstrated how the PRS that was used by participants earlier in the day to vote for the "big ideas", is used in her large, introductory cell biology lecture class to identify student misconceptions, followed by just-in-time-teaching and ending with an assessment of their understanding. Dr. Nancy Pelaez, also from CSU Fullerton, described

"Using CPR in Biology Classes". CPR or Calibrated Peer Review is a web-based tool that allows students to learn about important course topics by reviewing the written work of their peers after they have been "calibrated" by a set of writings that they evaluate, developed by the instructor. This tool allows instructors of large classes to increase the use of writing as a tool for learning and for assessment without increasing their grading load. Dr. Jeff Bell from CSU Chico presented "Helping Students Learn How to Think Like Scientists Using Simulations of Biological Experiments". He presented samples of assignments that use a computer-based simulation, which permits students to design genetics experiments to test their hypotheses and rubrics he developed to grade these assignments. Dr. Kathy Williams from San Diego State University presented "Using Classroom Assessment Strategies to Enhance Learning in College Biology Classes". She "uncovers" what students know by using small quizzes and writing activities in every class meeting and then helps to improve their understanding based on what she learns from these assessments. She has evaluated the effectiveness of this technique by giving unannounced "recall exams" to assess retention and found that student scores were a grade higher than when she taught the course without these initial assessments of what students know. These frequent quizzes and writing activities also improved student writing skills as well as their understanding of basic level concepts. Because of the late hour, Dr. Kathleen Fisher, also from San Diego State University, opted to present the software, Semantica, which helps students in "Scaffolding Thinking" so they can construct their knowledge and understanding by complex concept mapping, during a break on the following day. Trial use of the Semantica software for educators is available at: http://www.semanticresearch.com/downloads/edu/index.php

Breakout Session #4: Developing Measurable Learning Objectives

The main purpose of this session was to familiarize faculty with the process of developing student learning outcomes (SLOs) tied to the big ideas that were generated in the prior session. These outcomes were to be stated as measurable or assessable outcomes. Dr. Tina Hartney (Cal Poly Pomona) gave a short presentation entitled, "Student Learning Outcomes: What, Why, and How" to introduce the concept of SLOs in backwards design, their value and use, and the attributes that should be considered when articulating SLOs. Having programmatic and course-level SLOs facilitates the development of appropriate assessments. Dr. Hartney also presented examples of appropriate assessments that are linked to SLOs. Her presentation was a key component of this session and set the rationale for this breakout session.

New teams of faculty were assigned one of the six synthesized big ideas (see Breakout session #3) and asked to create assessable or measurable learning outcomes appropriate at the core/foundational level for their assigned "big idea". Teams were instructed to use the revised Bloom's taxonomy, located in their folder as a resource for determining the level of cognitive competency expected for their particular learning outcome or goal and to identify the appropriate verbs that could be used for developing assessments of the stated learning goal. Teams were then asked to develop appropriate assessments for the learning goal or outcome that they had developed. Each team then presented to the whole group, the learning outcomes or objectives or goals and samples of assessments that were measures of achieving these outcomes, objectives, or goals.

Concluding Activities: Discussing the Issue Bin, Campus and CSU-wide Action Planning

The workshop was concluded by Elaine McClanahan leading the group in a review of items posted in the "Issue Bin", those topics that were important to consider at a different time than when they were first mentioned. Each item was discussed, resolved as an action item, or discarded as no longer being an issue. Some of the issue bin items that were resolved by discussion include: How is what we do today aligned with what was done in the 1999 workshop? What does the administration accept and expect for assessment? Is there reason to fear that team teaching will fail for lack of monetary support? Young faculty have the greatest reason to be involved in the content and direction of course development but also have the greatest expectations imposed on them for other areas (i.e. research), how do we resolve that? Role of science education and faculty distrust of "science educationalese". How do you do group work and still have individual accountability? What assessments other than test questions can you use to assess student learning outcomes? What models are there for core programs? Some unresolved issues were: Do we need to create students capable of competing in a global society? If yes, we need to think about this in our reform processes. Should a major start with two or more course "surveys" of much or all of biology with the assumption that much of this survey will be "covered" again in more depth in required upper division courses OR will you teach major areas of biology only once in required courses, OR will you require a major discipline of biology (e.g. genetics) in one or two courses once in the entire curriculum?

Each campus participant was instructed to develop an action plan for their department in response to what they had learned from the workshop. These plans included the action, the responsible party for carrying out the action, and the target date for completing the action. This information was created in duplicate, for the campus and for the workshop's Group Memory. All representatives planned to disseminate the relevant ideas and recommendations gleaned from this workshop to their chair and departmental faculty. Campuses at different stages of revising or reforming their core/foundational curriculum planned to continue their work and those that had not developed student learning outcomes, planned to do so. CSU Hayward, Long Beach, and Sacramento planned to develop departmental retreats that would utilize a facilitator.

The CSU-wide actions were mainly to compile references on active learning and assessment websites for dissemination to CSU biology departments and to exchange Retention, Tenure, and Promotion documents that support curricular reform efforts of faculty. CSU Fullerton plans to create a plan to develop student learning outcomes for the topics proposed by IMPAC for introductory biology courses to aid in articulation, one of the goals of Project QUE, which supported this workshop. Several participants planned to discuss the development of CSU-wide student learning outcomes at the meetings of the Biology Council.

Evaluation of the CSU Biology Core/Foundational Curricula Revisions Workshop

There were two forms of evaluation of the workshop. At the end of the session, the facilitator, Elaine McClanahan, conducted a Plus/Delta assessment of the workshop, i.e., what were the good things (Pluses) and what should be changed (Deltas). Plus items included: Leading by example, the facilitator, breakfast was good, all the resources in the notebook, enthusiasm of participants, process to collect a large amount of data and distill it quickly, distillation of work done yesterday to a coherent product to take the next step, amount of

information captured, student helpers, issue bin process, wonderful desserts last night, and location conducive to work and to take a break outside. Deltas included: Faster feedback on requests for information of surveys that preceded the workshop, match what's presented and what's in the notebook, more diverse grouping of teams, use a different procedure for sharing curricular design breakout #2, share what you are currently doing in your campus in a breakout, more protein for breakfast, shorter, less intense day, free time to process day's events, free time at night, do workshop in the fall or earlier in the spring.

Participants were asked to complete an anonymous evaluation of the workshop. Generally, participants cited the opportunity to work with colleagues from other campuses and to hear about what other campuses are planning or have accomplished in revising their curriculum as the greatest value of the workshop. Several cited learning how to construct student learning outcomes and their assessments a valuable experience. When asked what worked best at the workshop, most felt that the breakout processes involving small groups of faculty allowed work to be accomplished, simultaneously encouraged getting to know participants, and modeled processes they could use in their department to involve all during brainstorming sessions. Several cited that the workshop was very well planned and greatly helped by the direction provided by a facilitator. Several suggestions were made to improve future, follow-up workshops. These include improving the diversity of the team compositions, more time for informal interactions, a shorter first day (many complained it was too long and tiring, especially the evening session after dinner), instructions for some of the activities in the breakout sessions could be clearer, a longer workshop earlier in the spring, a whole workshop on assessment tied to student learning outcomes that have been developed. In response to the request to comment on anything else, participants responded with: commendations for the work done by the planning team for a very well organized workshop and resource materials, congenial and infectious enthusiasm of colleagues to work with, need for more protein for breakfasts, more time to work although the increase cost and time away from home was acknowledged, and one individual who commented that there was too much policing and use of jargon that biologists do not use daily. Numerical scores for the level of satisfaction (1= not satisfied to 4=very satisfied) indicate that in general most participants were satisfied (average of all scores was 3.3 ± 0.30 (SD), ranging from 3.8 to 2.6) with the effectiveness, efficiency, purpose, processes, and outcomes of the workshop. The item with the lowest score was the question whether participants were satisfied with the workshop activities in developing an agreed-upon list of system-wide key concepts for foundational programs in the biology major. It is clear that this was beyond the scope of this single workshop but a process was initiated for achieving this goal and should be pursued in a future workshop (see below).

Recommendations from the Planning Team for Next Steps:

Much was accomplished in this workshop in terms of sharing developments in curricular revisions and reforms on various CSU campuses and the different processes that may be used to effect change. However, this workshop is clearly one that initiated several processes that will require follow-up actions. The following are recommendations based on the activities of the workshop and discussions among members of the planning team:

Future workshops such as this one should occur annually to continue the processes initiated by this workshop and the 1999 workshop that developed a list of learning goals for the biology major. These workshops should:

- Continue the development of a system-wide list of student learning outcomes and their assessment for the core or foundational programs for the biology major. Currently,

IMPAC has disseminated a list of topics for the biology lower division core courses with the aim of aiding articulation. However, this list does not include important skills. Additionally, the level of achievement with respect to topics listed is unclear, thus assessments of achievement are likewise unclear. A list that included desired skills and appropriate assessments aligned with these desired outcomes would greatly facilitate articulation with community colleges and other campuses. It is possible that this can be achieved by working with IMPAC, since this was a suggested goal in their 2002-2003 annual report.

- Provide a forum and opportunity to exchange information about curriculum development and reform. This would facilitate change and increase the efficiency of change since time and resources are always in short supply.
- Provide an opportunity for further faculty development on assessments and how to link them to student learning outcomes.

The Biology Council plays a pivotal role in accomplishing many of the tasks necessary to develop a system-wide list of student learning outcomes for the core or foundational programs in biology. The CSU system has clout and as a representative body of the biology departments throughout the CSU, the Council can be a national leader in many aspects of curricular reform. These are some of the tasks for the Council that are recommended:

- Create a system-wide body of faculty interested in curricular reform. A sub-group of faculty could be charged (and supported with some release time) with planning the system-wide workshops and to write grants to support such meetings.
- Create a section on the Council's website, where curricular issues, information, and assessment plans may be shared.
- Continuously remind Council members that they need to be more pro-active about sharing what occurs at the Council meetings with their faculty to assure proper and timely dissemination of important information. This also includes other stakeholders in curricular revisions, such as the lead faculty for biology in the statewide IMPAC project.
- Develop a means for ratifying system-wide actions that would greatly aid the efforts in developing a dynamic (i.e., one that would be altered periodically as circumstances and the field changes) listing of student learning outcomes for core, foundational curricula and their assessment.

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