**Appendix 1. Linking Course Research through Scientific Threads.** The three scientific threads (Toxicology, Bacterial Diversity and Fungal Ecology) connect introductory, intermediate and advanced courses participating in the SIRIUS project. Each course entry describes the research study and key activities that scaffold learning as students move from introductory to advanced levels. Both the Bacterial Diversity and Fungal Ecology Threads have one additional course (not shown) involved at the intermediate level, BIO 139: General Microbiology and BIO 160: General Ecology, respectively. The SIRIUS Project also employs the Department of Biology's two statistical analysis courses, BIO 100: Introduction to Scientific Analysis and BIO 167: Quantitative Methods in Biology, to further analyze data sets from the other courses participating in the program.

| | Toxicology | Bacterial Diversity | Fungal Ecology |
|---|---|---|---|
| **Introductory** | **BIO 1. Biodiversity, Evolution and Ecology: Impact of fertilizer use on *in vitro* cultures of invertebrate organisms sampled from the American River.**<br>-In vitro study<br>-Microscopy, dichotomous keys<br>-Reading and analyzing literature<br>-Statistical analysis using Excel<br>-Standard lab write-up<br>-Data summaries to SIRIUS website | **BIO 2. Cells, Molecules and Genes: Human impacts on bacterial communities sampled from multiple sites on the American River.**<br>-Metagenomic DNA Isolation<br>-PCR to amplify 16S ribosomal genes<br>-Cell, colony and CFU analysis<br>-Community report and presentation<br>-Sequences to GenBank<br>-Data summaries to SIRIUS website | **BIO 2. Cells, Molecules and Genes: Human impacts on bacterial communities sampled from multiple sites on the American River.**<br>-Metagenomic DNA Isolation<br>-PCR to amplify 16S ribosomal genes<br>-Cell, colony and CFU analysis<br>-Community report and presentation<br>-Sequences to GenBank<br>-Data summaries to SIRIUS website |
| **Intermediate** | **BIO 127. Developmental Biology: Impact of human-derived toxins on population dynamics of *C. elegans* nematodes cultured on agar.**<br>-In vitro design, experimental modeling<br>-Microscopy, digital image capture<br>-Create hypotheses from data and lit.<br>-Excel analysis of team and course data<br>-Full journal-style report<br>-Data summaries to SIRIUS website | **BIO 184. General Genetics: PCR products produced in BIO 2 are cloned to produce a library stored for full analysis in BIO 145.**<br>-Plasmid cloning of BIO 2 PCR product<br>-Transformation and colony selection<br>-Restriction analysis of plasmids<br>-Build annotated plasmid library<br>-Standard lab write-up<br>-Library to SIRIUS website | **BIO 128. Plant Anatomy & Physiology: The physiological roles of fungi in plant establishment and growth before and after restoration.**<br>-Root sampling of live oak, valley oak<br>-Pristine, urban, agriculture, mining<br>-Fungal identification, quantification<br>-Data entry and community analysis<br>-Samples frozen for DNA analysis<br>-Data summaries to SIRIUS website |
| **Advanced** | **BIO 187. Advanced Cell Biology: High-throughput analysis (96-well plate spectrometry) of toxins on viability and apoptosis of mammalian cell culture.**<br>-Students identify toxins in fresh water<br>-Review literature, propose mechanism<br>-Design experiment, run and analyze<br>-Full grant proposal-style paper<br>-Team PowerPoint presentation<br>-Publication of accumulated data | **BIO 145. Diversity of Microorganisms: Analysis of local bacterial communities by anatomical, physiological and genetic methods.**<br>-Advanced cell and colony analysis<br>-Selective differential media isolation<br>-Colony forming unit (CFU) analysis<br>-Biochemical analysis of metabolism<br>-Public poster presentations<br>-Data summaries to SIRIUS website | **Bio 180. Advanced Molecular Biology: The fungal diversity at the roots of multiple plant species before and after restoration.**<br>-Metagenomic DNA Isolation<br>-PCR to amplify 18S ribosomal genes<br>-DNA analysis and species profile<br>-Full journal-style report<br>-Team PowerPoint presentation<br>-Publication of accumulated data |

**Appendix 2. SIRIUS FLC goals and professional development activities for the Summer Institute and two Peer Evaluation Workshops.**

| **Overarching Goals for SIRIUS FLC:** | **Professional Development Activities:** |
|---|---|
| Create a productive and collaborative environment for developing the SIRIUS CUREs. Develop specific research plans for 12 courses in Biology and integrate them conceptually and longitudinally into 3 scientific threads. | • Presentations by PIs and guest experts provided current knowledge and training to support the development of CUREs.<br>• Hands-on activities and break out group discussions (by courses and threads) provided time for participants to share knowledge and ideas and begin developing curriculum.<br>• Whole group discussion provided venue for coordinating the curriculum across all courses.<br>• Daily surveys provided time for participants to reflect on learning and identify questions/needs. |

| **Summer Institute: June 2015**<br><br>**Daily Goals:** | **Daily Activities:** |
|---|---|
| Monday: Provide relevant background and training for creating CUREs. Develop an understanding of the use of inquiry-based pedagogies in the traditional research laboratory and the classroom to enhance student content knowledge, research skills and attitudes about science/research. | • Faculty prepared by reading Linn et al., 2015, Auchincloss et al., 2014 and Buck et al., 2008.<br>• Presentation provided overview of UREs, CUREs and Inquiry-based teaching/learning – focusing on similarities and differences.<br>• Faculty used Buck et al. rubric to evaluate and discuss the inquiry levels of existing department lab curricula.<br>• Guest speakers, Drs. Anne Beranger and Erin Palmer from UC Berkeley, discussed UREs.<br>• Presentation provided example of scaffolding strategies used to develop Model Lab (BIO127).<br>• Participants worked on CURE goals and scientific work plans in course teams. |
| Tuesday: Collect and share resources to support the science underlying the SIRIUS CUREs. Develop a shared vision on scientific quality and integrity for the SIRIUS Project and on the relevant background literature and datasets for the SIRIUS American River science threads. | • Teams accessed and archived web materials/information on the American River.<br>• Whole group discussed long-term sustainability of the data collection, potential usefulness of the data to existing faculty labs, scientific rigor and the potential to publish, the development of citizen scientists (service learning opportunities).<br>• Thread groups discussed overall scientific strategy. |

| | |
|---|---|
| Wednesday: Provide relevant background and training for creating CURE-specific assessments. Develop a working knowledge of the rules and limitations for using student- and faculty-derived information to assess the impacts of SIRIUS. | • Presentation provided overview of current literature focused on the assessment of UREs/CUREs.<br>• Short training conducted on Human Subjects Research and the IRB process.<br>• Presentation provided overview of assessment strategies and instruments used to evaluate SIRIUS CUREs; baseline data presented.<br>• Course teams discussed course-specific assessments to evaluate CUREs.<br>• Whole group discussed overall assessment strategy and timeline. |
| Thursday: Provide an overview of web-based tools and resources and provide training related to scientific instrumentation for use in the SIRIUS CUREs. Develop an understanding of the use of teaching and research technologies in the undergraduate classroom. | • Presentation provided overview of emergent technologies in the classroom.<br>• Presentation followed by discussion of e-laboratory notebook.<br>• Presentation followed by discussion of the e-portfolio system.<br>• Overview of the Keck-funded mobile research technologies available for use in CUREs.<br>• Participants toured labs and had opportunity to use instruments/equipment.<br>• Course teams discussed the integration of technologies into course designs. |
| Friday: Develop a shared vision and strategy/plan for creating safe, effective and responsible research activities as part of the SIRIUS Project. | • Presentation by EH&S followed by discussion of safety in student research; course teams filled out forms used to identify safety concerns.<br>• Presentation provided overview of Responsible Conduct of Research and campus resources.<br>• Teams reported initial course development plans.<br>• Group discuss scaffolding of research across threads and next steps. |

| **Peer Evaluation Workshop 1: May 2016** | |
|---|---|
| **Goals:** | **Activities:** |
| Inform SIRIUS FLC members about the labs implemented in the previous academic year and perform peer evaluation of these labs (Series 1 courses) | • Course teams presented overview of course curriculum and thoughts on implementation.<br>• Participants reviewed course documents and provided feedback.<br>• Teams developed proposal for revisions. |
| Inform SIRIUS FLC members about labs under development and perform status review of these labs (Series 2 and Series 3 Courses, and the Keck Foundation-funded Non-Bio Courses) | • Course teams presented overview of course curriculum underdevelopment.<br>• Group provided feedback.<br>• Teams developed proposal for future development/revisions. |
| Coordinate efforts around assessment of SIRIUS courses | • PIs reviewed assessment tools used across the curriculum and presented data for Series 1 labs. |
| Discuss additional funding opportunities and partnerships | • Federal funding (NSF, NIH, HHMI)<br>• W.M. Keck Foundation<br>• CSU-wide funding sources<br>• Campus-wide funding sources<br>• Government agencies: USGS, Fish and Wildlife, EPA |

| **Peer Evaluation Workshop 2: May 2017**<br><br>**Goals:** | **Activities:** |
|---|---|
| Reflect on the implementation of course modules and discuss results in course teams | • Participants completed Laboratory Course Assessment Survey (LCAS), modified for instructors.<br>• Course teams discussed LCAS results and identified curricular components that could use improvement/modification. |
| Inform SIRIUS FLC members about the labs implemented in the previous academic year and perform peer evaluation of these labs (Series 2 courses); Inform the SIRIUS Community about the second implementation of the Series 1 Courses and perform peer evaluation of these labs. | • Course teams presented overview of course curriculum and thoughts on implementation.<br>• Participants reviewed course documents and provided feedback.<br>• Teams developed proposal for revisions. |
| Inform SIRIUS FLC members about labs under development and perform status review of these labs (Series 3 Courses, and the Keck Foundation-funded Non-Bio Courses) | • Course teams presented overview of course curriculum underdevelopment.<br>• Group provided feedback.<br>• Teams developed proposal for future development/revisions. |
| Develop a working knowledge of the SIRIUS website and consensus of the preferred formats for sharing data. | • PIs provided update on website development and led discussion on website content (e.g., presenting data from courses). |
| Collaboratively develop Longitudinal Skills Profile that can lay the groundwork for a complete scaffolding of skills development | • PIs provided overview of Skills Profiles for BIO 2, 127 and 187 (as examples).<br>• Course teams discussed and recorded their Skills Profiles online.<br>• Group discussed Longitudinal Skills Profile across all course modules. |
| Develop Student Learning Outcomes (SLOs) and direct assessments for course modules. | • PIs conducted workshop on writing student learning outcomes (SLOs).<br>• Teams revised/drafted SLOs for each course module.<br>• Teams proposed direct assessments of learning for several course SLOs. |

**Appendix 3. Responses to End-of-Peer Evaluation Workshop 1 survey questions regarding 1) achievement of workshop goals and 2) planned changes to curriculum.**

| **1) As a result of the Peer Evaluation Workshop, I am/was…** | **% Agreement** |
|---|---|
| Better informed about the SIRIUS labs that have been implemented. | 100% |
| Better informed about the SIRIUS labs under development. | 100% |
| Able to share my expertise with other lab teams. | 93% |
| Able to benefit from the expertise of others in the development/improvement of my lab design(s). | 93% |
| **2) As a result of the Peer Evaluation Workshop, I plan to make changes to…** | **% Agreement** |
| The scientific work plan for my course. | 53% |
| Student learning outcomes related to content knowledge. | 53% |
| Student learning outcomes related to technical skills. | 47% |
| Student learning outcomes related to professional skills. | 27% |
| Assessment tools and strategies. | 40% |

**Appendix 4. Responses to End-of-Peer Evaluation Workshop 2 survey question regarding achievement of workshop goals.**

| The Peer Evaluation Workshop allowed an appropriate amount of time and support to… | % Agreement |
|---|---|
| Reflect on labs that have been implemented. | 93% |
| Review and discuss all SIRIUS courses. | 100% |
| Develop a longitudinal skills profile. | 93% |
| Preview the SIRIUS website and discuss data for dissemination. | 73% |
| Develop/revise student learning outcomes. | 93% |
| Preview Series 3 course curriculum | 100% |

**Appendix 5. Summary of responses to Peer Evaluation Workshop 2 survey question regarding participant's greatest needs.**

| Participant responses to survey question, "Following this Peer Evaluation Workshop, what are your greatest needs for implementing/improving your SIRIUS lab?" |
|---|
| Help with data management (organization) |
| Strategy for collaborative sample collection |
| Help restructuring course (to gain time for CURE) |
| Money for equipment/help budgeting for CURE |
| Faculty training (for non-FLC instructors) |
| Help promoting faculty buy-in (across multi-section courses) |
| Help developing curriculum (e.g., bioinformatics) |
| Help coordinating the use of equipment (needed for multiple CUREs) |
| Help facilitating the sharing of curriculum (group work/peer evaluation/writing and presenting) |
| Help writing Student Learning Outcomes |
| Help planning assessment strategies |