MCS New Course Proposal Form

General Information

Course Title: Summer Research Institute

Instructor(s): Gordon Rule, A. Javier Lopez

Course Number: 03-270

Prerequisites: 03-121 or 03-151; 09-105 or AP equivalents. Registration in this course will be by special permission only. It will only be open to rising sophomores who are selected for participation in the research component of the Summer Research Institute. Participants in SRI must register for this course.

Semesters Offered: Fall Spring X Summer-All Summer 1 Summer 2

Course Offering Frequency: Every academic year

Suggested Days and Times: F 12:30 to 1:30 pm

Evaluation Type: X Letter Grade Pass/Fail

Special Facilities Needed: Lecture

Course Unit Justification

Units: 3

In Class Hours: 1.5 hr per week

Recitation Hours: 0 hr per week

Lab Hours:

Out of Class Hours: 3 hr per week

Target Population: Rising Sophomores participating in the SRI program.

Anticipated Enrollment: 15

Rationale for Course (Background):

The Summer Research Institute (SRI) is an immersive research experience for rising sophomores that has been offered since 2002 (see Appendix) and has exhibited great success in preparing students for subsequent independent research under the mentorship of individual faculty. This course will accompany the established SRI research internship, formalizing the instruction and assessment of skills in data analysis and interpretation as well as in the written and oral communication of scientific results. During the 10 weeks of SRI, students work in teams of three or four on research projects linked to the research programs of MCS faculty. SRI projects focus on biological/biomedical
problems but typically involve multi-disciplinary approaches that differ from team to team and from year to year. Thus, different students are exposed to different conceptual and technical content through their specific projects. However, all students need to master a common set of tools and skills in data analysis, interpretation and communication in order to be successful scientists. This course will complement the SRI research experiences by providing unified instruction on this set of skills.

Course Description:

All students will be trained in lab safety, maintenance of lab records and notebooks, use of the research literature, and oral and written presentation skills, including good scientific practice and the effective use of visual content. To develop their communication skills, every student will write two reports, present an oral research update to the rest of the class each week, and give a final talk at the end of the course. The written reports will be in the form of scientific research papers with an abstract, background/introduction, materials and methods, results and discussion. The first will be on a common project carried out during Week 1 “Boot Camp” (see below). The second will be on the student’s team-specific project carried out during the rest of the summer. Each student will prepare a final reflection document to help consolidate their experience.

Throughout the course, formal instruction and assessments will be coordinated and integrated with the research experiences to provide real-life context that will emphasize the practical importance of the course content and reinforce learning. Reciprocally, the course activities (e.g. weekly discussions and oral presentations) will help all students gain an appreciation for the broad range of research problems and approaches involved in the different team projects.

During the first week of SRI (known as “Boot Camp”) all students will be trained in lab safety, maintenance of lab records and notebooks, use of the research literature, and use of essential public databases and bioinformatic tools for the analysis of DNA, RNA and proteins. During this same week all students participate in a common experimental project for training in essential techniques of DNA isolation and manipulation, engineering of protein expression constructs, and protein purification, where all of the above skills already become relevant. Instruction on communication skills will also begin during this week with a joint group meeting and preparation for the required report on the experimental Boot Camp project, to be submitted during the second week.

During weeks 2-10, when students transition into their different team projects, all SRI fellows will meet in a weekly joint session with faculty to make oral presentations on their research progress and to receive feedback on their developing skills in data analysis, interpretation and communication. The presentations will describe the rationale, goals, approaches, current results and overall status of the project. Presentations will be by teams but each student in a team will be expected to contribute to and deliver a portion of each presentation.
Students will be expected to devote 45 hours to this course during the 10-week session, aside from time spent on their SRI research. This breaks down as:

15 formal class hours: 1 hour each during Week 1-10 plus 5 hours during Week 1
10 hrs for preparation of presentations
10 hrs for preparation of 2 reports plus final reflection document
10 hrs on reading for Bootcamp and project background.

Outcomes:

• Students will learn good practices for laboratory safety.
• Students will know how to search for information in the scientific literature and how to read a scientific paper.
• Students will know how to access and use essential public databases.
• Students will know how to access and use essential bioinformatic tools to analyze sequences and structures of nucleic acids and proteins.
• Students will understand good scientific practice for written and oral communication.
• Students will learn how to put together a clear and informative presentation and how to make effective use of audiovisual presentation tools.
• Students will learn to collaborate in teams.
• Students will be prepared to engage in subsequent long-term individual research projects mentored by faculty in MCS or elsewhere.

Grading/Assessment: Grades will be based on class participation, lab notebooks, weekly in-class presentations, and two written reports.

Course Catalog Description:

This course provides rising sophomores who participate in the Summer Research Institute (SRI) with training in data analysis and scientific communication to complement their research internships. Before initiating their SRI research projects, students will receive formal instruction in laboratory safety, record-keeping, use of the scientific literature, and use of essential databases and bioinformatic tools. As they proceed with their projects, they will be mentored to enhance their skills in data interpretation and oral and written communication through discussions, weekly oral presentations of research progress, preparation of two written research reports and a final presentation. SRI students participate in team projects linked to the research programs of MCS faculty. Projects generally involve multidisciplinary approaches involving molecular biology, chemistry, biochemistry, bioinformatics and structural, cellular, or developmental biology. All students receive training in a common set of essential laboratory methods in molecular biology and biochemistry before initiating their specific team projects.
Appendix: The SRI Program

The SRI program was initiated by Dr. Elizabeth Jones with funds from an HHMMI Professor Award and was supported by this and other HHMI awards through 2014, when HHMI educational funding priorities shifted in other directions. The SRI program has exhibited great success in preparing students for subsequent independent research under the mentorship of individual faculty. SRI has taken students from all majors and from both the Pittsburgh and Qatar campuses, in an effort to build multidisciplinary research teams. It has taken students with long-standing interest in research but also students who may only have developed such an interest during their first year at CMU. During SRI, students work in teams of three or four on real research projects proposed by MCS faculty. These projects focus on biological problems but typically involve multi-disciplinary approaches including molecular biology, genetics, bioinformatics and computational biology, chemistry, biochemistry and structural biology, and cell and developmental biology. Regardless of project, all students are trained in essential methods of molecular biology and biochemistry. Additional methods, such as fluorescence imaging, site-directed mutagenesis, DNA sequencing, protein structural analysis by NMR, physical chemistry of nucleic acid complexes, or use of specialized bioinformatics tools are introduced in the specific team projects and may vary from year to year.

During Week 1 (“Boot Camp”) students receive training lab safety and in essential methods of molecular biology, biochemistry and bioinformatics, including purification and manipulation of DNA, molecular cloning and generation of expression constructs, bacterial transformation, electrophoretic analysis of DNA and proteins, and protein purification. This section of the course involves a common project so that all students share the same experience and learn the same set of basic skills. During week 2 students complete boot camp activities and transition into their team projects, which they choose based on presentations and readings provided by the sponsoring faculty.
During Weeks 2-10 ("Team Projects") students work in teams of three on specific projects. Once a week every team gives an oral presentation to the rest of the SRI students and instructors describing their research progress. The students receive faculty feedback not only on the science but also on communication skills. Students present final written reports at the end of the summer.

Selection of students for SRI:

Eligibility – Rising sophomores from MCS and other units with an interest in pursuing undergraduate research. The purpose of SRI is to prepare inexperienced students for later individual undergraduate research under the mentorship of individual faculty of their choice (not necessarily SRI faculty nor faculty providing the SRI team projects). Therefore, preference is given to students who have not already been engaged in research, either through the Bacteriophage Genomics Course or in individual faculty laboratories. SRI students are expected to work on their SRI team projects full time – they cannot also be engaged in faculty-mentored research projects outside of SRI nor enroll in courses other than the SRI companion course (03-270).

Application and selection – Students must submit an application comprising an essay describing their academic interests and career aspirations, their interest in research and the SRI program in particular, and previous research experiences together with a CV and transcript and at least one faculty reference. Participants will be selected based on suitability of the SRI experience to their interests and career goals, academic preparedness to initiate research in the relevant subject areas, and potential impact of the SRI experience on their subsequent academic trajectory. Preference will be given to students who have not already been engaged in research.