

## **Second-Semester Undergraduate Research in Biology Guidelines and Expectations for both Students and Research Mentors within or outside of the Biology Department (BI 351 and BI 451)**

The [general guidelines](#) for all courses for credit in undergraduate research and/or honors are applicable to this course and should be incorporated with the following guidelines that pertain the earning general education credit for taking this course.

### **Responsibilities of the Student:**

*HUB requirements:* Earning general education units involves the ongoing efforts made during your first semester(s) or units of research experience. This includes continuing required attendance and participation in laboratory meetings on a regular basis, and the continued experience and use of the online research information and literature is expected. This semester there are ongoing requirements for earning a HUB unit in RIL and additional requirements for earning a HUB unit in CRI during your second 4-credit semester of research.

### **Responsibilities of All Research Mentors:**

In the second semester working with the student, it is expected that they will continue about learning research information resources and how to use them; in particular, any that might be specific to the research area, i.e., the Protein Database if working on protein structure. In addition, the oral communication skills started in the first semester of 4-credit research should be fostered by continued attendance and participation in weekly laboratory meetings.

By the second semester of research, mentors should challenge students in their research. Mentors are required to respond to students' projects in a way that forces the students to think outside of the box, pursue new ideas, or take risks. Encourage students to be creative and use input

### **General Education (BU Hub)**

#### **1. Research and Information Literacy (RIL):**

*Learning Outcome 1:* Students will be able to search for, select, and use a range of publicly available and discipline-specific information sources ethically and strategically to address research questions.

*Accessing Information:* This skill is needed for selecting a group and a project, and student should become familiar with methods for exploring and understanding the research literature, if not already achieved from earlier courses. Among the many tools available in the biological sciences, PubMed stands out as the most critical for *accessing information*. Other platforms, such as SciFinder, can also play a vital role in achieving Information Literacy depending on the research group. Nonetheless, *comfortable*

familiarity with PubMed is an expected starting point for students engaged in the first semester of research.

*Assessing Information:* Progress in research and assessing research information is achieved in individual meetings with the group PI, and through group meetings, which all groups hold. At these meetings, literature is routinely discussed and judged as to the suitability for application to the research project at hand, and to the validity of the research. As with all courses, successful training in assessing information begins with the mentor. One advantage of Research and Information Literacy training in the research lab is the “flipped classroom” environment. In the sciences, the laboratory is the ultimate flipped classroom, and the novice researcher has the expertise and experiences of other undergraduate, graduate, and post-doctoral fellows also in the group as catalysts for the training. These other researchers serve as invaluable mentors, and the group meetings become a critical vehicle for information assessment.

*Using Information Ethically:* Ethics training is an important part of all research groups and should be incorporated in discussions at group and individual meetings.

*Learning Outcome 2:* Students will demonstrate understanding of the overall research process and its component parts, and be able to formulate good research questions or hypotheses, gather and analyze information, and critique, interpret, and communicate findings.

*Producing Information through Inquiry:* As per current practice, in order to register for research, a description of the project, and the student’s role in the project must be submitted. This process includes approval of the PI and/or Biology faculty-member sponsor in multiple rounds of drafts and final approval before submission. The Biology Director of Undergraduate Studies reads and approves all applications, and proper use of the literature is expected. Appropriate literature citations are required for the abstract of the project description and if found deficient, the DUS contacts the student for corrections in the research literacy and scholarship.

## **2. Creativity/Innovation (CRI):**

*Learning Outcome 1:* Students will demonstrate understanding of creativity as a learnable, iterative process of imagining new possibilities that involves risk-taking, use of multiple strategies, and reconceiving in response to feedback, and will be able to identify individual and institutional factors that promote and inhibit creativity.

*Learning Outcome 2:* Students will be able to exercise their own potential for engaging in creative activity by conceiving and executing original work either alone or as part of a team.

Those students who continue as juniors or seniors in a research laboratory for their second semester in the same laboratory will earn a CRI unit. Initial training in

creative thinking will be accomplished in the first semester of registered research and realized in the second. By the time students are participating in their second semester of research, they are expected to be comfortable in performing some experiments on their own and to use their own thoughts and creativity. The exercise of creative potential in design and execution of experimental work will be achieved during the second semester. Sometimes this will occur while working independently or sometimes as part of a team. Different PIs involve their UGR students in different ways in this regard, but both are valuable and effective ways to learn of their own potential. In the inevitable success and failures, they get immediate feedback as well as more considered feedback from colleagues and mentors. As with all research, risk-taking, use of multiple strategies, and reconceiving in response to feedback are critical features of undergraduate research success. As students learn how to perform research in biological sciences it becomes clear that it's an iterative, if not repetitive, process of experiments and analysis, whereby new possibilities are imagined, weighing risks of slight alterations in approach or involving other strategies, and performing experiments anew. Research is a natural incubator for developing creative thought and students should be allowed this time with mentors challenging students to go beyond what they are learning as more experience in research is gained. Given this time, students should grow into leadership roles within a research group, and their creative ideas contributing to the project. All this done in consultation with mentors providing feedback along the way.