Manual for Chemical Biology Mentors

Chemical Biology Laboratory

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I. Introduction (back to Table of Contents)

Welcome to Chemical Biology Laboratory! As a Teaching Assistant for this course, you will have the privilege of participating in an experience that is unlike most other teaching assistantships. Rather than simply guiding undergraduate students through a set of defined experiments with pre-determined outcomes, you will be guiding students through a novel research project. Your interactions with the students will be uniquely dynamic, just as scientific research is unique and constantly changing. By accepting the challenge of becoming a TA for Chemical Biology Laboratory, you are taking advantage of an opportunity that promises to be as rewarding as it is instructive.

Since this is the inaugural semester for the course, we expect that revision will be necessary for future semesters. As empiricists, we know that theories are adjusted in light of experience. Keep track of your impressions, your thoughts about what does and doesn't work well, and your recommendations for changes. Communicate with Connie Allen throughout the semester. A form at the end of this document invites feedback on some specific issues. Draw upon your compiled thoughts to respond to this and return it to Dr. Allen when the semester ends.

This manual serves as a supplement to the lab manual prepared for the students in the course. Where relevant, the sections correspond to those found in the Chemical Biology Laboratory Manual, and there are a few extras especially for you.

II. Your Role as a Mentor (back to Table of Contents)

In the Middle Ages, unskilled youths apprenticed with master craftsmen in order to learn a trade. Over time, the young person advanced to journeyman status and, finally, to that of master. Ideally, the master-apprentice relationship was nurturing and supportive. Today, this mentoring tradition is still practiced in the discipline of science. Mentorship takes place in many forms: between a principal investigator and his or her lab members, between the senior and less experienced members of a lab group, and between graduate and undergraduate students. The art of doing science cannot be fully captured in a how-to

manual. The most important subtleties must be communicated personally, through side-by-side, hands-on experiences along the way. Helping your students become more adept in the lab is more like teaching them to play the violin than teaching them to type.

As fledgling research mentors, the teaching assistants play a nodal role in this course. You have been selected because of your maturity and your integrative approach to research questions. As you guide your students in their research, you will be their primary mentor. In this role, you will experience a blend of responsibility and freedom. To paraphrase Jean-Paul Sartre, we are condemned to be free, and we are responsible for all of our actions. You are responsible for guiding the project, for giving advice and frequent direction, and for helping students discover the nature of the research experience. At the same time, there is freedom involved. Because you are not following a strictly outlined schedule, at points you must decide how to proceed. This is a chance for you to make judgments – and errors! – and to put what you have learned from your own scientific mentors into practice.

Problem solving is a key dimension of your mentoring role. You have considerably more laboratory experience than your students; therefore, they will look to you for all kinds of help. Some will expect you to know everything. You will be able to answer many questions simply by drawing upon your own knowledge. Other questions will require you to consult external resources, such as the literature, a senior lab member, technical assistance from a company, or faculty members at Yale. Students will learn by example that science (and lab work) proceeds when people have the humility to ask questions. Scientific research is above all a community, not a place for solo heroics. It will benefit your students to be involved in the answer-seeking: for example, you might have one of them place a call to a company or look into the properties of a reagent. Sharing this responsibility will both help you and empower the students.

Initially, your students will probably be unfamiliar with the differences between a typical laboratory course and the approach of this course. Expect questions such as, “was this supposed to happen?” and “what do I do now?” As you guide your students through Chemical Biology Laboratory research, share your knowledge, creativity, and excitement about research. Because the results are always unknown, help your students formulate questions that shape their modes of inquiry and focus their approach. For each step in the research project, the students should understand i) what question they are asking, ii) how the procedure they are performing will address this question, and iii) how this particular part of the experiment relates to the overall questions guiding their research project.

Another key part of your mentoring role is encouraging creativity and freedom – a sense of exploration, within limits – and discernment about what is fair game to try and what the TA must be asked about. Show students the value and necessity of thinking on one’s feet, along with the value and necessity of reflecting seriously upon results. There will be some repetitive elements of the course, as students repeat experiments to refine data or to correct previous mistakes. Help students see that this kind of repetition is the only way one develops expertise as a skilled researcher, and that even the best theoretician relies upon his or her technique. Further, help them see that the whole endeavor of science rests

upon the reproducibility of results. Encourage them to work out answers to their questions, to propose solutions, and to be creative. Advocate camaraderie and rapport, since more minds working together increase the likelihood of coming up with a solution.

As for your own progress through the semester, it's important that you maintain a sense of the big picture. What question is the research trying to address, and what do you want the students to accomplish toward that answer? Each sub-group has an ideal road map plotted out, but the designers of this course recognize that things will probably not go exactly as planned. By relying upon your expertise, and consulting with Connie Allen as needed, help students maintain focus and progress toward their goals. Interact with your "colleagues," or your fellow Chemical Biology Laboratory TAs, since they may have some useful contributions to make to your sub-group, and vice versa. Your creativity and ideas are welcome and appropriate, as long as they contribute to developing a research experience with integrity.

Though this is a challenging assignment, it is not thankless. You too will be developing and refining skills needed in research (e.g., mentoring, project supervision, coordination of a group). Keep in mind that this intellectual challenge will be a valuable part of your scientific development. The opportunity to mentor four students in a research sub-group provides a window into your future possibilities. You will learn about your own strengths and weaknesses in this role, and how to draw from the former and fortify the latter. As you develop your scientific and mentoring skills in tandem, this teaching experience will enhance your career development. Future principal investigators and employers will take note of the experience; feature it prominently in your resume.

III. Time Management Tips (back to Table of Contents)

The expected time commitment for this assignment is similar to other laboratory teaching assistantships. Chemistry Department guidelines stipulate that a teaching assistantship should require no more than 225 hours per semester (about 18-19 hours per week spread over a twelve-week semester). Because your work for this course will overlap with your own graduate research, however, it may be difficult to discern how much time you are spending on the course. Time spent preparing for and in laboratory sessions, grading, and participation in the Friday lecture series counts directly toward teaching hours.

Efficient planning and organization will help you manage your time, and you should expect the same from your students, as well as helping you to achieve it. Students are charged with the task of reflecting upon their research between laboratory periods. Part of your job is to respond to their thoughts and questions that arise outside of the classroom. Reasonable accessibility is essential. Discerning what is unreasonable, and how to respond to such, are things you will learn. If at any time during the semester you are feeling overwhelmed, or need assistance, don't hesitate to speak up. Communicate your concerns to Connie Allen and she will help you work out an effective solution.

IV. Semester Schedule (back to Table of Contents)

Each sub-group will follow the same Friday lecture schedule, but schedules for lab period activities vary by sub-group. In addition, revisions may be required as the course

progresses. Each project has specific raw material requirements for the beginning, and you will be participating in fine tuning details of the project preparation during the Fall 2003 semester (e.g., determining the exact sequences of molecules that will be used in an experiment). Most projects also require some hands-on preparation or other involvement by the TA, outside of laboratory periods, throughout the semester. There are built-in "check-points" for each project, which will help you ensure that the students make adequate progress and avoid the frustration of getting stuck (e.g., by Week 5, any student in sub-group 1 who doesn't have a pure β-peptide for further experimentation will be supplied with purified material to work with).

Students are required to attend all scheduled laboratory sessions and Friday lectures. For each laboratory session, you will decide whether to begin in SCL 3 for a sub-group discussion, or whether your students will proceed directly to the lab. Let them know in advance to avoid wasted time. You will need to take attendance for your sub-group. Refer attendance issues to Connie Allen. For some of the projects, there will occasionally be times when tasks need to be completed outside of scheduled laboratory time. It is your job to see that these happen, and you can encourage the students to participate (perhaps by showing up to help on a rotating basis spread among members of the sub-group). Students will learn that research does not typically occupy only two, four-hour chunks of time per week, and it will enhancing their sense of responsibility for their projects.

Although not required, all Chemical Biology Laboratory students are invited to attend Schepartz group seminars, held every Friday at 3 p.m. in SCL 201 (the Faculty Lounge). When a research presentation will be especially beneficial to your sub-group, you should inform your students and encourage them to attend. Help students understand the importance of these seminars by drawing their attention to the importance of the process. Participation will enhance their understanding of the science and provide valuable exposure to data interpretation and problem-solving approaches.

Another component of your mentorship will be teaching the students in your sub-group how to make constructive use of downtime. While they are waiting to use an instrument, waiting for cells to grow, etc., help them make progress in other ways. For example, they may prepare solutions ahead for the next steps, or review relevant literature or protocols. It might also be a good time to work on data analysis, ponder results, or even to assist other students in their sub-group with their experimental tasks. You may wish to bring in examples of your own lab results (e.g., an Excel file of CD data) to give them practice at analysis. Toward the end of the semester, students can spend time working on their *JACS*-style final report. Idle hands or idle minds are not acceptable in this laboratory course (just as they are not acceptable in your own research lab!).

Try to stay a few weeks ahead of your students by anticipating supply and equipment needs. If you are out of a supply, you may purchase it from the stockroom using a designated HHMI charge number. All such purchases must be documented, and records submitted to Connie Allen. Notify Connie Allen when a supply or reagent that must be ordered is running low so that she can re-order it. In a pinch, you may borrow materials from the Schepartz lab, but reliance upon this habit will infringe upon that lab and will

indicate poor advance planning. Significant deviation from the original schedule may require you to check whether rescheduling of instrument time is necessary (e.g., to avoid conflicting with HPLC use by the other sub-groups, or with use of the departmental CD spectrometer). Also, for equipment that will be accessed in the Schepartz laboratory (such as the Analyst and the shaker-incubator), try to anticipate times of heavy use by the Chemical Biology Laboratory students and make appropriate arrangements with members of the Schepartz lab.

Your weekly tasks should include the following:

- Think about what each student will be doing, and what progress you expect him or her to make.

- Review new safety or waste-related guidelines as techniques come up in the schedule.

- Alert Connie Allen to any supplies or reagents that are running low.

- Review and grade the Experimental Plans that each student submits at the beginning of a lab period. In most cases, you will know what their plans are, so having them write out their plans is an exercise primarily to guide their preparation for each lab period.

- Grade the lab notebooks of the four students in your sub-group according to the guidelines in the student lab manual, Section 8. You will be collecting the carbon copies daily at the end of each lab session; try to return them promptly so students maximally benefit from your comments.

- You will be responsible for delivering several of the Friday lectures. Topics will be assigned well in advance of the semester to allow time for preparation. (See schedule on the next page.) Use the 50-minute time block as you see fit to inform the students about your topic, emphasizing the practical application thereof. The lectures need not use the entire fifty minutes. Additional time will be devoted to informal meetings between sub-groups or by individual sub-group, as needed. Use the time to talk about progress, to troubleshoot, to discuss results, and plan ahead.

- When you prepare slides for your Friday lectures, please submit them to Connie Allen in advance. These will also be posted on the course website for reference. Consider having printouts available, but beware of the danger of having three attention-demanding features (screen, paper, voice). Overcome the potential for overload by choosing how to focus your students' attention.

- Consider making weekly notes to yourself to keep track of any suggestions you have for ways to improve Chemical Biology Laboratory in future semesters.

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Week	***Laboratory activities***	***Friday Lecture Topic***	***Lecturer***
Friday Jan. 17	(Monday Schedule) Orientation for MW lab students		
1 Jan. 19	Specific activities determined by sub-group	Introduction to CB Lab Solid phase peptide synthesis	Guarracino
2 Jan. 26	Specific activities determined by sub-group	HPLC	Kritzer
3 Feb. 2	Specific activities determined by sub-group	Bacterial Expression of Proteins ***QUIZ 1***	Maranda
4 Feb. 9	Specific activities determined by sub-group	Characterization of peptides and proteins: amino acid analysis and mass spectrometry	Guarracino
5 Feb. 16	Specific activities determined by sub-group	Circular dichroism and analytical ultracentrifugation: theory and applications	Kritzer
6 Feb. 23	Specific activities determined by sub-group	Analysis of binding reactions at equilibrium: theory ***QUIZ 2***	Maranda
7 March 1	Specific activities determined by sub-group	Progress reports from sub-groups	
March 8	SPRING RECESS		
March 15	SPRING RECESS		
8 March 22	Specific activities determined by sub-group	Analysis of binding reactions at equilibrium: methods	Maranda
9 March 29	Specific activities determined by sub-group	Phage display ***QUIZ 3***	Kritzer
10 April 5	Specific activities determined by sub-group	Affinity chromatography	Kritzer
11 April 12	Specific activities determined by sub-group	DNA sequencing Discussion of Final Report details	Guarracino
12 April 19	A. Mini-presentations by sub-groups B. Conclusions/Check-out	Short talks by Chemical Biology Faculty with summer research opportunities	
Monday April 26	(Friday Schedule)	***QUIZ 4***	

V. Lab Safety and Waste Management (back to Table of Contents)

Review the safety and waste guidelines in the student lab manual. You should be familiar enough with these guidelines that you never need to think about safety issues or how to dispose of waste; it should be second nature. Students will receive a presentation on safety and waste guidelines as part of the orientation to the lab at the beginning of the semester. Insist that your students follow safety rules scrupulously and handle waste in the proper manner. Remind them to ask about how to dispose of something, and regularly check waste containers to monitor for overflow, check that caps are replaced, and so on. Set a good example by wearing safety goggles and a lab coat, keeping food out of the lab, using gloves when necessary, and so on.

Emergency Telephone Numbers

Chemical or Biological Spills or Exposure	785-3555
Yale Campus Police	111 (2-4400)
Yale Health Services	432-0123

VI. Keeping up with the Literature (back to Table of Contents)

In addition to the textbook resources that correspond to the Chemical Biology Lecture course, each sub-group has a list of journal articles for background reading. The student lab manual also provides guidelines for becoming acquainted with the literature (suggested search terms and links to starting points for online searches). Though there are no specific supplementary reading requirements, this is an area where students will learn from your practice. Alert them to relevant papers that you come across, and suggest additional literature references as you see fit. By your example, help students become aware of the exciting resources that are available to them. Encourage them to bring in papers they find interesting, and ask them to articulate insights they gleaned from them. Also, help them see that the scientific literature is an important component of the culture of science, and it provides a valuable forum in which scientists communicate, debate, and evaluate one another's work.

VII. Protocols for Chemical Biology Laboratory Techniques (back to Table of Contents)

The student lab manual contains links to descriptive protocols for most of the laboratory techniques students will be using. Most of these protocols were adapted from those posted on the Schepartz laboratory website, some with significant modification. The protocols are meant to serve as a guide, a source for trouble-shooting help, and to provide background theoretical information for the lab techniques. In some cases, the specific instrument that the students will use is not on site yet (such as the HPLC and the CD spectrometer), which limits the specific user instructions that can be supplied. Be familiar with protocols that students in your sub-group will encounter, and prepare to assist them with details not included in the online lab manual.

This is an area where your feedback will be especially valuable for future semesters of Chemical Biology Laboratory. Evaluate the usefulness of the protocols. Which protocols were especially helpful? Which would benefit from further modification? Should any

additional technique-related information be added to the lab manual? Be sure to include your suggestions in the end-of-semester evaluation form found at the end of this manual.

VIII. Assessment: The Chemical Biology TA Experience (back to Table of Contents)

Both the TAs and the students in Chemical Biology Laboratory will be asked to participate in a variety of assessment activities. These will not demand a lot of time, yet your thoughtful engagement will be valuable for the future of the course. In addition to the organizational and logistics-oriented feedback you will be asked to provide, we are interested in assessing the impact of this course on the goals and aspirations of the Teaching Fellows who lead the sub-group research projects. We will seek to determine whether graduate students who function as Teaching Fellows for ***Chemical Biology for Sophomores!*** (1) are more likely to pursue an academic career than Teaching Fellows who lead more traditional chemistry or biology courses; and (2) are more confident of their abilities as research directors. In addition, we will also assess whether the experience has altered their view on the relative merits of different approaches to teaching science at the undergraduate level.

Teaching Fellows will be assessed before, during, and after their participation in the course. Related activities may involve, but are not limited to, the following:

1. A training workshop before the course begins

2. End-of-semester evaluation questionnaire to generate immediate feedback to inform the course planning for subsequent semesters (see next page)

3. Surveys before, during, and after the semester to assess the TAs' experiences (and to compare it with that of other TAs)

4. Sustained communication over a longer term to determine the impact of this experience on the TAs' educational and career paths

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IX. End-of-Semester Evaluation by TAs (back to Table of Contents)

Please submit considered responses to the questions below. Your input will be a valuable aid for planning this course for future semesters. Thank you!

1. Comment on the project design. What were the points of difficulty? What components worked well?

2. Did your sub-group make satisfactory progress? What general or specific revisions would you recommend for project pacing in the future?

3. In your opinion, how did the students in your sub-group feel about the project and the progress they made over the semester?

4. Comment on the TA workload. On average, how many hours did you spend per week working on this course? Do you feel that this is appropriate, too much, or too little?

5. Did you find this experience to have a helpful, a hindering, or a neutral effect on your own research project over the course of the semester?

6. Did you find SCL 168 and the equipment available there adequate for the laboratory's needs? Do you have any suggestions for improving this space for future laboratories?

7. Comment on the protocols included in the online lab manual. Which ones were especially helpful, and which ones would benefit from additional modification?

8. What items (equipment, supplies, reagents) were shared with the Schepartz lab? Was this arrangement beneficial or detrimental? Are there things that you would recommend changing in the future?

9. Comment on the mentor role you assumed for your sub-group. Did you feel prepared? Were you challenged? What did you learn about yourself?

10. In your opinion, how does being a TA for this course compare to being a TA for other undergraduate labs at Yale?

11. In general, do you have any specific complaints, frustrations, or constructive criticisms related to your experience as a Chemical Biology Laboratory TA? What additional suggestions for improvement do you have?

12. What were the best parts of your experience as a Chemical Biology Laboratory TA?

Thank you for your feedback.