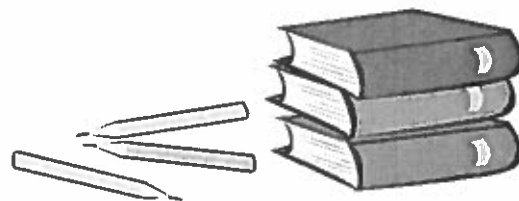


PROFESSIONAL SKILLS

The Merits of Training Mentors

Christine Pfund,^{1,2} Christine Maidl Pribbenow,³ Janet Branchaw,⁴
Sarah Miller Lauffer,³ Jo Handelsman^{1,3*}

Good mentoring can be learned.



In research universities and colleges, mentoring is one of the most important skills for faculty because it affects both research productivity and the quality of training for undergraduate students, graduate students, and postdoctoral researchers. Moreover, the diversity of science is dependent on the quality of mentored research, because this experience is a key to

attracting underrepresented groups to science (1–5). In the past, many faculty learned skills such as mentoring on

the job. In recent years, various organizations have developed training programs to help prospective and new faculty learn skills such as grant writing, laboratory management, and classroom teaching, but mentoring has been largely absent. In response to this need, we developed and evaluated a mentor-training seminar. The seminar is intended to improve mentors' skills and to enhance the research experiences of undergraduate students.

In research universities, graduate students and postdoctoral researchers often serve as the primary mentors for undergraduate researchers (see photograph, this page). This arrangement provides undergraduates with guidance from a person who is accessible and whose primary focus is laboratory work. It also provides graduate students and postdoctoral researchers with experience as mentors. Therefore, our seminar focused on training graduate students and postdoctoral researchers as mentors, but it is also suitable for developing mentoring skills of faculty.

The Wisconsin Mentoring Seminar

The Wisconsin Mentoring Seminar was developed using an iterative approach of design, testing, evaluation, and revision. The seminar (table S1) reflects participation of eight cohorts of mentors led by four facilitators at the University of Wisconsin–Madison (6). This version of the seminar has since been implemented and evaluated at 11 research universities including UW-

Madison. The objectives of the Wisconsin Mentoring Seminar are to train mentors to communicate effectively, to consider issues of human diversity, to discuss mentoring approaches, and to apply a “scientific teaching” approach to mentoring (7). The seminar consists of eight sessions of discussion facilitated by faculty or staff using a collaborative, problem-solving format. The participants read articles and case studies, write biographies of their undergraduate students, compare their goals with those of their undergraduate researchers, explore time-management strategies, and write mentoring philosophies.

Communication skills are addressed with the use of exercises that include interviews with their undergraduate researchers. The aim is to help the mentors to recognize and reconcile differing expectations about time commitment, independence, and skill proficiency. Mentors learn the value of discussing mentoring issues with peers and faculty through discussion in the seminar itself and discussions they are required to initiate with their research advisers.

The mentors discuss the value of and accommodations for diversity in the laboratory. Consideration of how their own work habits, cognitive styles, attitudes, gender, ethnicity, physical ability, educational background, and nationality differ from that of their mentees complements readings of research on stereotypes and unconscious prejudices. The group brainstorms about approaches to overcoming cultural biases.

The mentors are encouraged to approach teaching with the same rigor and spirit of experimentation that they bring to research (7). They develop their own systematic approaches by identifying objectives and approaches to overcome associated impediments. They evaluate their approaches through feedback from their undergraduate researchers, peers in the laboratory, and research advisers.

Mentors design strategies to help undergraduates become outstanding experimental-

ists and to develop confidence, creativity, and independence. In addition to discussing their own scientific and ethical standards and effective ways to transmit those standards to their students, the mentors grapple with the challenge of reconciling high standards with flexibility and personal style.

Implementation and Evaluation

Over the past 2½ years, the mentoring seminar has been run 22 times at 11 institutions. To evaluate the impact of the seminar, we gathered data about mentors who either did or did not participate in the seminar and the undergraduate researchers under their supervision at UW-Madison. Although we were unable to conduct a randomized experiment, we reduced the impact of self-selection by using as the untrained comparison group entire cohorts of mentors who were not offered the opportunity to participate in the mentoring seminar and compared

them with cohorts in which all members were required to participate. Five of the seminars were conducted concurrently with summer undergraduate research programs. Three of the mentoring seminars at UW-Madison were offered in conjunction with a semester-long program in which research laboratory experience partially replaced an introductory biology laboratory course requirement. From these cohorts, we surveyed

85 mentors and 84 undergraduate researchers. In addition, we interviewed 10 undergraduate researchers and 11 graduate students and postdoctoral mentors about their experiences. We have since surveyed trained mentors and the facilitators of the mentoring seminar from 11 institutions. The surveys used in this study are available (6).

Graduate students, postdoctoral researchers, and research scientists served as the primary mentors, and each seminar was facilitated by a faculty or staff member. The facilitator was provided with a manual, “*Entering Mentoring*,”



Mentoring in microbiology. Graduate student Courtney Robinson (left) participated in the Wisconsin Mentoring Seminar while she mentored undergraduate researcher Yolied Ramos at the University of Wisconsin–Madison.

¹Wisconsin Program for Scientific Teaching, Department of Plant Pathology, ²Center for the Integration of Research, Teaching, and Learning, ³Women in Science and Engineering Leadership Institute, ⁴Center for Biology Education, University of Wisconsin, Madison, WI 53706, USA.

*To whom correspondence should be addressed. E-mail: joh@plantpath.wisc.edu

that contains reading material and detailed instructions for facilitating the seminar (6). All of the respondent facilitators found "Entering Mentoring" useful and interesting (table S2).

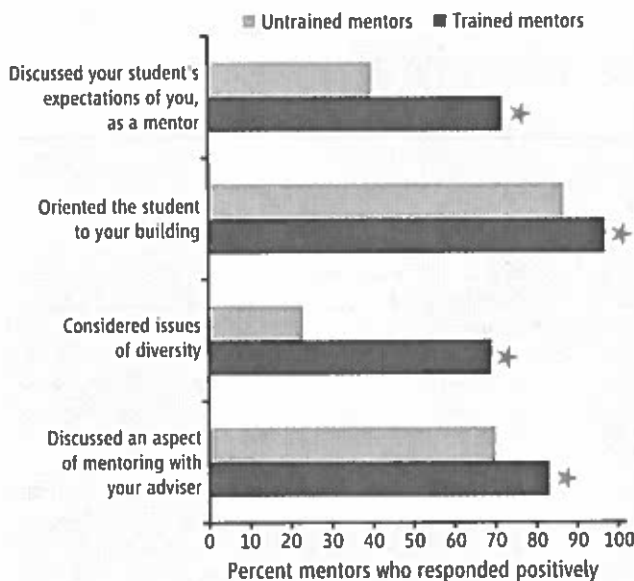
Surveys of 12 facilitators of the mentoring seminar from nine institutions indicated that all considered facilitating the seminar to be a positive experience that they would recommend to a colleague (table S3). Most (64%) indicated that their own philosophy of mentoring changed as a result of facilitating the seminar. Several facilitators said they were more aware of their students' needs and had more ideas about how to address these needs. One professor commented, "The mentors empowered me to be more bold in my own mentoring."

Our results indicate that the mentoring seminar was successful in achieving the set objectives: Mentors who participated in the seminar ("trained mentors") were significantly more likely to discuss expectations with their undergraduate

researchers, to consider issues of diversity, and to discuss mentoring with peers and faculty than were those who did not participate in the seminar ("untrained mentors") (see graph, this page). The mentors trained at UW-Madison and eight other research universities self-reported gains in a number of areas (table S4, A and B), and 87% said they would recommend the seminar to their peers. Mentors reported satisfaction with each of the discussion topics in the mentoring seminar, as shown in table S5. In addition, when mentors reflected on their mentoring after the training, they noted their intentions to work harder in future mentoring in many of the areas covered in the training, including setting clear expectations, regularly assessing their student's understanding, fostering independence, and asking colleagues for advice when confronted with a challenge in mentoring. Such insights about their mentoring were also reflected in their mentoring philosophies (table S6).

The mentoring seminar favorably influenced the undergraduate research experience. Students who had been previously mentored were asked to compare their experiences, and they consistently reported that mentors who participated in the seminar were more available to them, were more interested in them as individuals, and gave them more independence.

In the quantitative analysis, we found no significant difference between responses from undergraduates whose mentors did or did not participate in the mentoring seminar, in part because the undergraduate researchers had positive experiences regardless of the status of their mentor. Our results confirm published



Behaviors of trained and untrained mentors. Percentage of mentors who indicated that they engaged in the noted activity while mentoring an undergraduate researcher. Stars indicate that the difference between the trained and untrained mentors was significant ($P < 0.05$).

studies to this effect (1, 2), showing self-reported gains in 19 categories, with the greatest gains in "developing a research project" and "working independently on research" (table S7A).

Comparison of how undergraduates themselves and their trained or untrained mentors assessed the progress of the undergraduates (table S7, A and B) shows that trained mentors' assessments more closely matched the undergraduates' self-assessments (table S7C). Undergraduates working with trained mentors were more likely to agree with the statement that their mentor "regularly assessed the skills and knowledge that they had gained in the lab" ($P < 0.05$). We conclude that the seminar enhanced the ability of the mentors to assess the skills of their students and likely enhanced the accuracy of the undergraduate students' assessment of their own skills. Because alignment of mentee and mentor skill ratings is an important measure of the validity of self-reported data (3), mentor training may have the unexpected benefit of increasing the reliability of assessments based on self-reporting, which are often used to evaluate undergraduate research programs.

At the conclusion of the summer programs at UW-Madison, 80% of the mentors who participated and none of those who had not participated in the mentoring seminar said that their view of their own adviser was altered by the summer mentoring experience (table S8), enhancing the mentors' understanding of their advisers' mentoring strategies and their empathy for the challenges faced by advisers.

Conclusion

We developed a seminar on mentoring that fills a critical gap in graduate education and training of future faculty. Evaluation of the seminar suggests that it is an effective means of improving communication and evaluation skills that are essential to good mentoring.

Mentoring relationships between faculty and students are often cited as critical in the decisions of undergraduates to pursue graduate education, but the effective elements of those relationships are not clear (4, 8–10). In our study, undergraduate researchers who compared experiences with trained and untrained mentors stressed communication as a key feature of good mentoring.

The mentored research experience represents an intersection of many aspects of research and education in our research universities, offering an opportunity for generating multiple effects with a single intervention. The most direct effect is an improvement in the quality of the undergraduate research experience, which has been shown to be pivotal in attracting students in general, but especially racial minorities, to science (1–5). But we anticipate other effects, including an improved quality of undergraduate research, resulting in greater faculty satisfaction and perhaps a greater willingness to host undergraduate researchers. Training graduate students and postdoctoral researchers in mentoring might also produce a new generation of scientists who enter the professoriate as skilled mentors. The minimal resources required to teach this seminar seem worth investing to achieve these diverse outcomes.

References and Notes

1. Reviewed in E. Seymour et al., *Sci. Educ.* 88, 493 (2004).
2. D. Lopatto, *Cell Biol. Educ.* 3, 270 (2004).
3. C. M. Kardash, *J. Educ. Psychol.* 92, 191 (2000).
4. R. S. Hathaway, B. A. Nagda, S. R. Gregerman, *J. Coll. Stud. Dev.* 43, 614 (2002).
5. B. A. Nagda et al., *Rev. Higher Educ.* 22, 55 (1998).
6. J. Handelsman, C. Pfund, S. M. Lauffer, C. Pribbenow, *Entering Mentoring: A Seminar to Train a New Generation of Scientists* (Univ. of Wisconsin Press, Madison, 2005).
7. J. Handelsman et al., *Science* 304, 521 (2004).
8. A. W. Astin, *What Matters in College? Four Critical Years Revisited* (Jossey-Bass, San Francisco, 1993).
9. E. T. Pascarella, P. T. Terzini, *How College Affects Students* (Jossey-Bass, San Francisco, 1991).
10. J. C. Hearin, *Res. Higher Educ.* 27, 119 (1987).
11. We thank J. Heitz and the Biology 152 staff and the undergraduate researchers, mentors, and faculty who participated in this program. Supported by the University of Wisconsin–Madison and the Howard Hughes Medical Institute through a grant to J.H. from the Howard Hughes Medical Institute Professors Program. J.B. was supported by NSF grant no. 0402549.

Supporting Online Material
www.sciencemag.org/cgi/content/full/311/5760/473/DC1
 10.1126/science.1123806

Aligning Expectations

Case #1: *The Slow Writer*

A third year graduate student in my group is adept at performing experiments and analyzing data, but is a very slow writer. Last fall, I set multiple deadlines that this graduate student missed, while another student in my group wrote an entire thesis chapter, submitted a paper, and did experiments. Over winter break, the slow writer had a breakthrough and produced a fairly reasonable draft of a prelim proposal. However, because she produced it so close to the (planned) prelim date and did not have the presentation ready either, so I delayed the exam. To avoid delays in publications, I have taken the lead in writing manuscripts based on her work. However, to graduate with a PhD, I realize that she must write the dissertation, as well as the next manuscripts, herself. Setting deadlines for detailed outlines, manuscript/thesis sections, figures, etc. hasn't worked. Communicating the importance of manuscripts to the scientific endeavor hasn't worked. Encouragement hasn't worked. Veiled threats don't seem professional. Other than being patient, what should I do?

Guiding Questions for Discussion:

1. What are the main themes raised in this case study?
2. What could have been done to avoid this situation? What should the mentor do now? What should the mentee do now?
3. How do you find out what expectations your mentee has of you and for their research experience?

Aligning Expectations

Case #2: *Second Year Blues – A Mentee’s Perspective*

Ben is beginning his second year as a multidisciplinary post-doctoral research scholar at BIG U Academic Health Center. Though he has enjoyed working on his mentor’s research project, he is becoming anxious that he has not yet started an independent project. When he joined the lab two years ago, he had hopes of pursuing his own independent interests. Every time Ben tries to bring up his concerns with his mentor, it seems like his mentor can never find the time to have a discussion focused on Ben’s research goals. This situation is becoming frustrating because he likes his mentor and understands that the past few months have been extremely busy for his mentor due to a host of factors (economic budget constraints, preparing an NIH grant proposal, adoption of a new family member, etc.). Being politically astute, Ben is reluctant to make a “misstep”, yet he knows the clock is ticking. He is also concerned that his recent interests in basic mechanistic studies are too divergent from his mentor’s translational program and worries that it may conflict with his mentor’s expectations. He feels “stuck,” but doesn’t know what to do.

Guiding Questions for Discussion:

1. What are the main themes raised in this case study?
2. What kind of conversations regarding expectations might have been helpful earlier in this relationship?
3. What kind of conversations would be helpful at this point? Who should be involved in these conversations?

Expectations for Undergraduate Mentees*

1. **Send me weekly email updates on Fridays by 5 p.m.**, describing briefly what you've been working on, what you plan to do the following week, and any questions or troubles you had. Important things to include: project you've worked on, broken equipment, storage/equipment conflicts, if your data look weird.
2. **Attend lab meeting.** The entire lab assembles approximately once a week to discuss our research. Generally the person leading lab meeting will distribute reading materials in advance. You should read these materials and come prepared to participate actively in the discussion.
3. **Be organized.** There is a lot of overlap in projects, and it is essential that you keep track of all the samples the way that I specify. This includes updating the data spreadsheets and lab notebooks immediately.
4. **Read background information and protocols about our projects, and about our lab's research.** This includes the protocol handout, the wiki, and related journal articles from the lab that I've suggested. I'd love to discuss any journal article or protocol, so just say the word and we'll grab some coffee and chat.
5. **Be consistent with your lab schedule.** Email/call me if you are going to be very late or unable to make your scheduled lab time.
6. **Be independent.** I am periodically away, and I expect you to get things done well without me. Ask questions when I am around, but don't be afraid to try to do detective work on your own if I am not. We have a helpful experienced lab, so know that folks other than me may be excellent resources.
7. **Respect the lab area and your colleagues.** Keep it neat and ask if you have questions on equipment use, cleaning, etc. It is very important that you tell me if a piece of equipment breaks. Do not be worried that I will be angry. These things happen all the time in labs, and the important thing is that I know it is broken and can arrange to have it fixed.
8. **Let me know if you need anything from me as a mentor, or if you have questions.** Be up-front and I will do the same.
9. **I have an "open door" policy.** Let me know if you are having troubles or concerns that you want to talk about with me, work-related or not. My phone number is XXXXXX.

* From Ashley Shade, University of Wisconsin–Madison research mentor

Undergraduate Mentee Contract*

Undergraduate Mentee: _____

Graduate or Postdoc Mentor: _____

This contract outlines the parameters of our work together on this research project.

1. Our major goals are:

A. research project goals _____

B. mentee's personal and/or professional goals _____

C. mentor's personal and/or professional goals _____

2. Our shared vision of success in this research project is:

3. We agree to work together on this project for at least _____ semesters.

4. The mentee will work at least _____ hours per week on the project during the academic year, and _____ hours per week in the summer.

The mentee will propose his/her weekly schedule to the mentor by the _____ week of the semester.

If the mentee must deviate from this schedule (e.g., to study for an upcoming exam), he or she will communicate this to the mentor at least _____ (weeks / days / hours) before the change occurs.

5. On a daily basis, our primary means of communication will be through (circle):

face-to-face / phone / email / instant messaging / _____

6. We will meet one-on-one to discuss our progress on the project and to reaffirm or revise our goals for at least _____ minutes _____ time(s) per month.

It will be the (mentee's / mentor's) responsibility to schedule these meetings. (circle)

In preparation for these meetings, the mentee will:

In preparation for these meetings, the mentor will:

* Adapted from Branchaw, J. L., Pfund, C., and Rediske, R. (2010), *Entering Research: A Facilitator's Manual: Workshops for Students Beginning Research in Science*, W.H. Freeman & Company.

At these meetings, the mentor will provide feedback on the mentee's performance and specific suggestions for how to improve or progress to the next level of responsibility through (circle):

a. a written evaluation b. a verbal evaluation c. other: _____

7. The mentor will train the mentee on new techniques and procedures using the following (e.g., written directions, hands-on demonstration, verbal direction as mentee does procedure, etc.):

8. If the mentee gets stuck while working on the project (e.g., has questions or needs help with a technique or data analysis), the procedure to follow will be:

9. The standard operating procedures for working in our research group, which all group members must follow and the mentee agrees to follow, include (e.g., wash your own glassware, attend weekly lab meeting, reorder supplies when you use the last of something, etc.):

10. Other issues not addressed above that are important to our work together:

By signing below, we agree to these goals, expectations, and working parameters for this research project.

Mentee's signature: _____ Date: _____

Mentor's signature: _____ Date: _____

Professor's signature: _____ Date: _____

Graduate Mentee Contract*

The broad goals of my research program

As part of my job as a professor, I am expected to write grants and initiate research that will make tangible contributions to science, the academic community, and society. You will be helping me carry out this research. It is imperative that we carry out good scientific method, and conduct ourselves in an ethical way. We must always keep in mind that the ultimate goal of our research is publication in scientific journals. Dissemination of the knowledge we gain is critical to the advancement of our field. I also value outreach and informal science education, both in the classroom and while engaging with the public. I expect you to participate in this component of our lab mission while you are part of the lab group.

What I expect from you

Another part of my job as a professor is to train and advise students. I must contribute to your professional development and progress in your degree. I will help you set goals and hopefully achieve them. However, I cannot do the work for you. In general, I expect you to

- Learn how to plan, design, and conduct high-quality scientific research
- Learn how to present and document your scientific findings
- Be honest, ethical, and enthusiastic
- Be engaged within the research group and at least two programs on campus
- Treat your lab mates, lab funds, equipment, and microbes with respect
- Take advantage of professional development opportunities
- Obtain your degree
- Work hard—don't give up!

You will take ownership over your educational experience

- Acknowledge that you have the primary responsibility for the successful completion of your degree. This includes commitment to your work in classrooms and the laboratory. You should maintain a high level of professionalism, self-motivation, engagement, scientific curiosity, and ethical standards.
- Ensure that you meet regularly with me and provide me with updates on the progress and results of your activities and experiments. Make sure that you also use this time to communicate new ideas that you have about your work and challenges that you are facing. Remember: I cannot address or advise about issues that you do not bring to my attention.
- Be knowledgeable of the policies, deadlines, and requirements of the graduate program, the graduate school, and the university. Comply with all institutional policies, including academic program milestones, laboratory practices, and rules related to chemical safety, biosafety, and fieldwork.
- Actively cultivate your professional development. UW–Madison has outstanding resources in place to support professional development for students. I expect you to take full advantage of these resources, since part of becoming a successful engineer or scientist involves more than just doing academic research. You are expected to make continued progress in your development as a teacher, as an ambassador to the general public representing the university and your discipline, with respect to your networking skills, and as an engaged member of broader professional organizations. The graduate school has a regular seminar series related to professional

* From Professor Trina McMahon, University of Wisconsin–Madison

development. The Delta program offers formalized training in the integration of research, teaching, and learning. All graduate degree programs require attendance at a weekly seminar. Various organizations on campus engage in science outreach and informal education activities. Attendance at conferences and workshops will also provide professional development opportunities. When you attend a conference, I expect you to seek out these opportunities to make the most of your attendance. You should become a member of one or more professional societies, such as the Water Environment Federation, the American Society for Microbiology, or the American Society for Limnology and Oceanography.

You will be a team player

- **Attend and actively participate in all group meetings, as well as seminars that are part of your educational program.** Participation in group meetings does not mean only presenting your own work, but providing support to others in the lab through shared insight. You should refrain from using your computer, Blackberry, or iPhone during research meetings. Even if you are using the device to augment the discussion, it is disrespectful to the larger group to have your attention distracted by the device. Do your part to create a climate of engagement and mutual respect.
- **Strive to be the very best lab citizen.** Take part in shared laboratory responsibilities and use laboratory resources carefully and frugally. Maintain a safe and clean laboratory space where data and research participant confidentiality are protected. Be respectful to, tolerant of, and work collegially with all laboratory colleagues: respect individual differences in values, personalities, work styles, and theoretical perspectives.
- **Be a good collaborator.** Engage in collaborations within and beyond our lab group. Collaborations are more than just publishing papers together. They demand effective and frequent communication, mutual respect, trust, and shared goals. Effective collaboration is an extremely important component of the mission of our lab.
- **Leave no trace.** As part of our collaborations with the Center for Limnology and other research groups, you will often be using equipment that does not belong to our lab. I ask that you respect this equipment and treat it even more carefully than our own equipment. Always return it as soon as possible in the same condition you found it. If something breaks, tell me right away so that we can arrange to fix or replace it. Don't panic over broken equipment. Mistakes happen. But it is not acceptable to return something broken or damaged without taking the steps necessary to fix it.
- **Acknowledge the efforts of collaborators.** This includes other members of the lab as well as those outside the lab.

You will develop strong research skills

- **Take advantage of your opportunity to work at a world-class university by developing and refining stellar research skills.** I expect that you will learn how to plan, design, and conduct high-quality scientific research.
- **Challenge yourself by presenting your work at meetings and seminars as early as you can and by preparing scientific articles that effectively present your work to others in the field.** The "currency" in science is published papers: they drive a lot of what we do. And because our lab is supported by taxpayer dollars, we have an obligation to complete and disseminate our findings. I will push you to publish your research as you move through your training program, not only at the end. Students pursuing a master's degree will be expected to author or make major contributions to at least one journal paper submission. Students pursuing a doctoral degree will be expected to be lead author on at least two journal paper submissions, preferably three or four.
- **Keep up with the literature so that you can have a hand in guiding your own research.** Block at least 1 hour per week to peruse current tables of contents for journals or do literature searches. Participate in journal clubs. Better yet, organize one!

- **Maintain detailed, organized, and accurate laboratory records.** Be aware that your notes, records, and all tangible research data are my property as the lab director. When you leave the lab, I encourage you to take copies of your data with you. But one full set of all data must stay in the lab, with appropriate and accessible documentation. Regularly back up your computer data to the server (see the wiki for more instructions).
- **Be responsive to advice and constructive criticism.** The feedback you get from me, your colleagues, your committee members, and your course instructors is intended to improve your scientific work.

You will work to meet deadlines

- **Strive to meet deadlines: this is the only way to manage your progress.** Deadlines can be managed in a number of ways, but I expect you to do your best to maintain these goals. We will establish mutually agreed upon deadlines for each phase of your work during one-on-one meetings at the beginning of each term. For graduate students, there is to be a balance between time spent in class and time spent on research and perhaps on outreach or teaching. As long as you are meeting expectations, you can largely set your own schedule. It is your responsibility to talk with me if you are having difficulty completing your work, and I will consider your progress unsatisfactory if I need to follow up with you about completion of your lab or coursework.
- **Be mindful of the constraints on my time.** When we set a deadline, I will block off time to read and respond to your work. If I do not receive your materials, I will move your project to the end of my queue. Allow a minimum of 1 week prior to submission deadlines for me to read and respond to short materials, such as conference abstracts, and 3 weeks for me to work on manuscripts or grant proposals. Please do not assume I can read materials within a day or two, especially when I am traveling.

You will communicate clearly

- **Remember that all of us are “new” at various points in our careers.** If you feel uncertain, overwhelmed, or want additional support, please overtly ask for it. I welcome these conversations and view them as necessary.
- **Let me know the style of communication or schedule of meetings that you prefer.** If there is something about my mentoring style that is proving difficult for you, please tell me so that you give me an opportunity to find an approach that works for you. No single style works for everyone; no one style is expected to work all the time. Do not cancel meetings with me if you feel that you have not made adequate progress on your research; these might be the most critical times to meet with a mentor.
- **Be prompt.** Respond promptly (in most cases, within 48 hours) to emails from anyone in our lab group and show up on time and prepared for meetings. If you need time to gather information in response to an email, please acknowledge receipt of the message and indicate when you will be able to provide the requested information.
- **Discuss policies on work hours, sick leave, and vacation with me directly.** Consult with me and notify fellow lab members in advance of any planned absences. Graduate students can expect to work an average of 50 hours per week in the lab; postdocs and staff at least 40 hours per week. I expect that most lab members will not exceed 2 weeks of personal travel away from the lab in any given year. Most research participants are available during university holidays, so all travel plans, even at the major holidays, must be approved by me before any firm plans are made. I believe that work-life balance and vacation time are essential for creative thinking and good health and encourage you to take regular vacations. Be aware, however, that there will necessarily be epochs—especially early in your training—when more effort will need to be devoted to work and it may not be ideal to schedule time away. This includes the field season, for students/postdocs working on the lakes.
- **Discuss policies on authorship and attendance at professional meetings with me before beginning any projects to ensure that we are in agreement.** I expect you to submit relevant research results in a timely manner. Barring unusual circumstances, it is my policy that students are first author on all work for which they took the lead on data collection and preparation of the initial draft of the manuscript.

- **Help other students with their projects and mentor/train other students.** This is a valuable experience! Undergraduates working in the lab should be encouraged to contribute to the writing of manuscripts. If you wish to add other individuals as authors to your papers, please discuss this with me early on and before discussing the situation with the potential coauthors.

What you should expect from me

- **I will work tirelessly for the good of the lab group; the success of every member of our group is my top priority, no matter their personal strengths and weaknesses, or career goals.**
- **I will be available for regular meetings and informal conversations.** My busy schedule requires that we plan in advance for meetings to discuss your research and any professional or personal concerns you have. Although I will try to be available as much as possible for “drop-in business,” keep in mind that I am often running to teach a class or to a faculty meeting and will have limited time.
- **I will help you navigate your graduate program of study.** As stated previously, you are responsible for keeping up with deadlines and being knowledgeable about requirements for your specific program. However, I am available to help interpret these requirements, select appropriate coursework, and select committee members for your oral exams.
- **I will discuss data ownership and authorship policies regarding papers with you.** These can create unnecessary conflict within the lab and among collaborators. It is important that we communicate openly and regularly about them. Do not hesitate to voice concerns when you have them.
- **I will be your advocate.** If you have a problem, come and see me. I will do my best to help you solve it.
- **I am committed to mentoring you, even after you leave my lab.** I am committed to your education and training while you are in my lab, and to advising and guiding your career development—to the degree you wish—long after you leave. I will provide honest letters of evaluation for you when you request them.
- **I will lead by example and facilitate your training in complementary skills needed to be a successful scientist, such as oral and written communication, grant writing, lab management, mentoring, and scientific professionalism.** I will encourage you to seek opportunities in teaching, even if not required for your degree program. I will also strongly encourage you to gain practice in mentoring undergraduate and/or high school students, and to seek formal training in this activity through the Delta program.
- **I will encourage you to attend scientific/professional meetings and will make an effort to fund such activities.** I will not be able to cover all requests, but you can generally expect to attend at least one major conference per year, when you have material to present. Please use conferences as an opportunity to further your education, and not as a vacation. If you register for a conference, I expect you to attend the scientific sessions and participate in conference activities during the time you are there. Travel fellowships are available through the environmental engineering program, the Bacteriology Department, and the university if grant money is not available. I will help you identify and apply for these opportunities.
- **I will strive to be supportive, equitable, accessible, encouraging, and respectful.** I will try my best to understand your unique situation, and mentor you accordingly. I am mindful that each student comes from a different background and has different professional goals. It will help if you keep me informed about your experiences and remember that graduate school is a job with very high expectations. I view my role as fostering your professional confidence and encouraging your critical thinking, skepticism, and creativity. If my attempts to do this are not effective for you, I am open to talking with you about other ways to achieve these goals.

Yearly evaluation

Each year we will sit down to discuss progress and goals. At that time, you should be sure to tell me if you are unhappy with any aspect of your experience as a graduate student here. Remember that I am your advocate, as well as your adviser. I will be able to help you with any problems you might have with other students, professors, or staff.

Similarly, we should discuss any concerns that you have with respect to my role as your adviser. If you feel that you need more guidance, tell me. If you feel that I am interfering too much with your work, tell me. If you would like to meet with me more often, tell me. At the same time, I will tell you if I am satisfied with your progress, and if I think you are on track to graduate by your target date. It will be my responsibility to explain to you any deficiencies, so that you can take steps to fix them. This will be a good time for us to take care of any issues before they become major problems.

Mentoring Tool**Research Experience Expectations***

Objective: Students will articulate their motivations and goals for doing research, what they bring to the experience, and what they aim to learn from the experience.

PARTICIPANT MATERIALS

1. Why do you want to do research?
2. What are your academic and personal goals for your research experience?
3. What values, experiences, and/or perspectives will you bring to your research team?
4. What is your greatest concern about doing research?
5. What most excites you about doing research?

* Adapted from Branchaw, J. L., Pfund, C., and Rediske, R. (2010), *Entering Research: A Facilitator's Manual: Workshops for Students Beginning Research in Science*, W.H. Freeman & Company.

Mentoring Tool**Research Experience Reflections***

Objective: Students will reflect on what they learned and the goals they achieved during their research experience.

1. Was your research experience what you expected it to be? Why or why not?
2. What academic and personal goals did you achieve in your research experience? How do they compare to the goals you outlined at the beginning of your experience?
3. What values, experiences, and/or perspectives did you contribute to your research team? Were you able to contribute in ways that you did not predict? How?
4. How did you overcome your greatest concern about doing research? What was the most challenging aspect of your research experience?
5. What was the best part about your research experience? Are you planning to continue doing research? Why or why not?

* Adapted from Branchaw, J. L., Pfund, C., and Rediske, R. (2010), *Entering Research: A Facilitator's Manual: Workshops for Students Beginning Research in Science*, W.H. Freeman & Company.

Mentoring Tool

Letter of Recommendation*

Objective: Students will consider what they expect their mentor(s) to say in a letter of recommendation about them and reflect on whether their behavior and performance support these expectations.

One of the benefits of doing research is that you will get to know your mentor well, and he or she will be able to write a detailed letter of recommendation on your behalf when you move to the next stage of your academic or professional career. As you begin the research experience, reflect on the expectations and goals you established with your mentor. Consider what you would like him or her to be able to say about you at the end of the research experience and complete this draft letter of recommendation.

Date

Dear Selection Committee,

I am writing this letter in support of [*your name*], who is applying for [*job of your dreams*]. I believe [*your name*] is an excellent candidate for this position because

- 1.
- 2.
- 3.

Over the past few years, [*your name*] has worked in my research group in the Department of [*your department*] at the [*your campus*]. [*Your name*] is very skilled in the following areas:

- 1.
- 2.
- 3.

In short, I believe that [*your name*] would be a wonderful asset to your department/program/unit. I strongly recommend him/her.

Sincerely,
[*Your mentor*]

Do the things outlined in this letter of recommendation align with the goals and expectations you established with your mentor? If not, how can you adjust your goals and expectations so that you will have the opportunity to engage in activities that allow your mentor to comment on these things?

* Adapted from Branchaw, J. L., Pfund, C., and Rediske, R. (2010), *Entering Research: A Facilitator's Manual: Workshops for Students Beginning Research in Science*, W.H. Freeman & Company.

4. How will you assess your progress in mastering these competencies and skills?

- Mastery of coursework
- Mentor/instructor feedback
- Successful experimental outcomes
- Peer review

5. Who will help you reach your goals and how?

- Teachers
- Mentors
- Peers
- Family members

Goals	Competencies & Skills	Activities & Experiences	Assessment of Progress	Support People and Their Roles
Long-term 1.				
Intermediate-term 1. 2. 3.				
Short-term 1. 2. 3.				
Immediate 1. 2. 3.				

Examples of Skills

Research and Technical

- Critical reading (scientific literature)
- Experimental design
- Experimental techniques
- Computer skills
- Documentation/laboratory notebook
- Problem solving and troubleshooting
- Data and statistical analysis
- Critical analysis
- Responsible conduct of research
- Identification of new research directions and next steps

Professional and Interpersonal

- Reliability and follow-through
- Communication (oral and written)
- Writing (manuscript, grant, fellowship)
- Teaching
- Mentoring
- Collaborating and working in teams
- Giving/receiving constructive feedback
- Collegiality
- Networking

Management and Leadership

- Time management (meeting deadlines)
- Prioritizing and organizing work
- Leading and motivating others
- Research project management
- Budget management
- Supervising/managing people
- Delegating responsibility

Example 2: An IDP Worksheet (for the Next Year)

PARTICIPANT MATERIALS

An Individual Development Plan is a professional tool that outlines objectives that you and your mentor/supervisor have identified as important for your professional development. A comprehensive review of your career goals and objectives identified at the beginning of your appointment and during your semiannual appraisal provide constructive feedback from your mentor/supervisor that can help you become an independent investigator.

Career Goals/Objectives	Educational Activities	Research Projects/Products/Dates
Goal One: Objective 1. 2. 3.		
Goal Two: Objective 1. 2. 3.		
Goal Three: Objective 1. 2. 3.		

Please describe the plan that you and your mentor have for your transition from your current position to the next position.

Additional Comments:

Mentoring Tool

Roles for Your Research Mentor*

Objective: Students will consider the different roles that their research mentors play and reflect on which are most important to them.

Consider the different roles of research mentors listed below. Add other roles that may be missing from the list. Prioritize these roles according to your expectations, with #1 as the most important.

Role	Priority
Teach by example	
Train you in disciplinary research	
Improve your writing and communication skills	
Provide growth experiences	
Help build your self-confidence as a researcher	
Model and promote professional behavior	
Inspire	
Offer encouragement	
Assist with advancement of your career	
Facilitate networking with colleagues	
Help build the bridge between research and clinical work	
Other:	
Other:	
Other:	

* Adapted from Branchaw, J. L., Pfund, C., and Rediske, R. (2010), *Entering Research: A Facilitator's Manual: Workshops for Students Beginning Research in Science*, W.H. Freeman & Company.