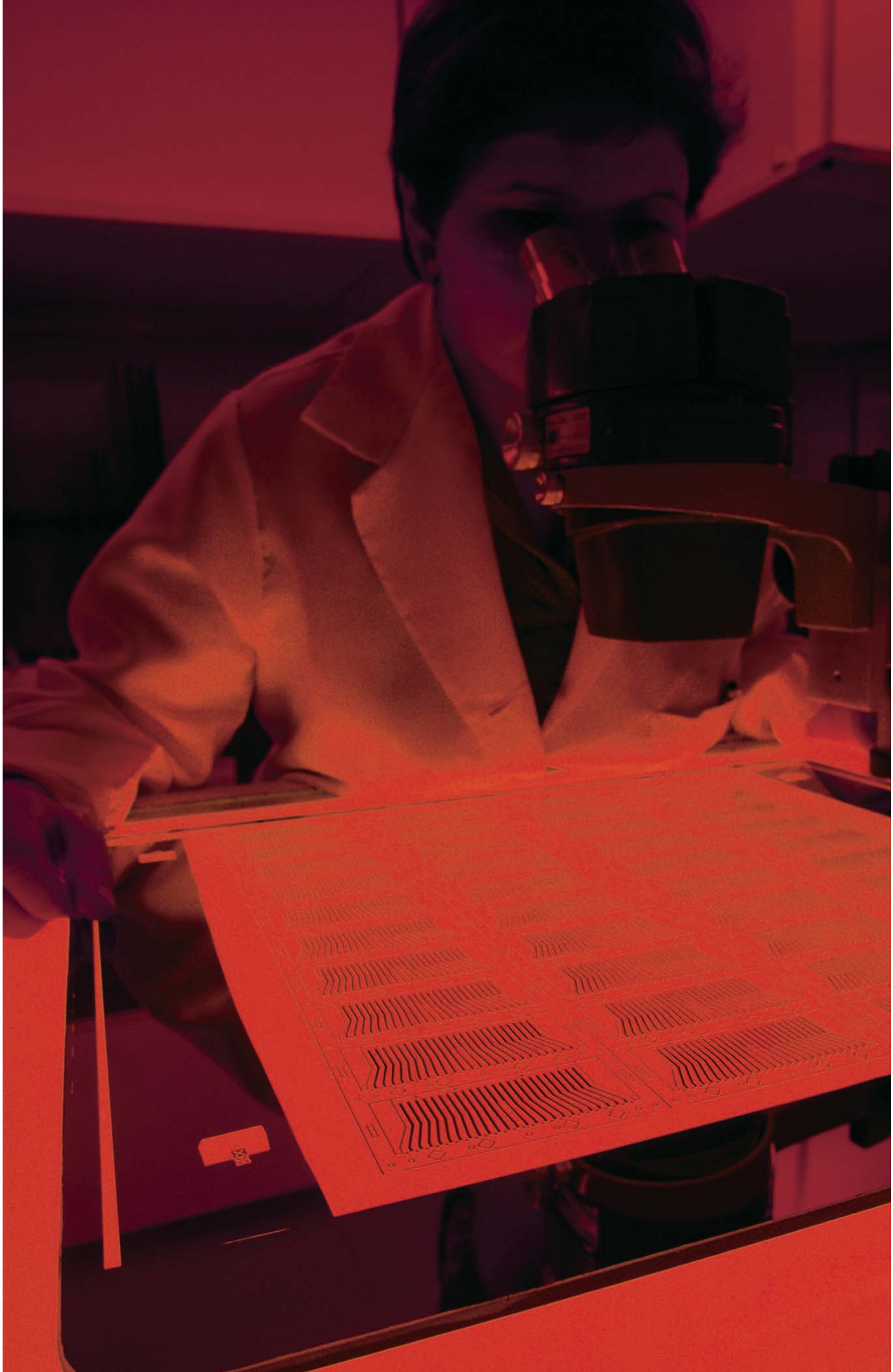


Chapter One: Research and Work Experience

Participating in research or working in the sciences or engineering can be one of the most rewarding and enriching experiences of your undergraduate career. These experiences can help you identify your specific interests and can provide you with valuable knowledge and experience that will prepare you for further education and a career in science or engineering. Most graduate schools expect applicants to have practical, real-life experience in a laboratory or engineering setting.

Types of Undergraduate Research/Work:

1. Academic year experiences

The student generally teams up with a faculty member from her/his school and works on an already existing project. Unless the student has chosen to volunteer his/her time, the student is either compensated monetarily or with class credit. Some colleges and universities have excellent research programs sponsored by organizations like the National Science Foundation, or National Institutes of Health, the McNair Program, other governmental agencies or private organizations like the Howard Hughes Medical Institute or the Sloan Foundation. Some programs offer scholarships to those who participate in research programs.

Engineering students may participate in co-op programs that place them in engineering firms for the summer or during the academic year. These experiences open doorways to jobs or provide recommendations for further study.

2. Summer research

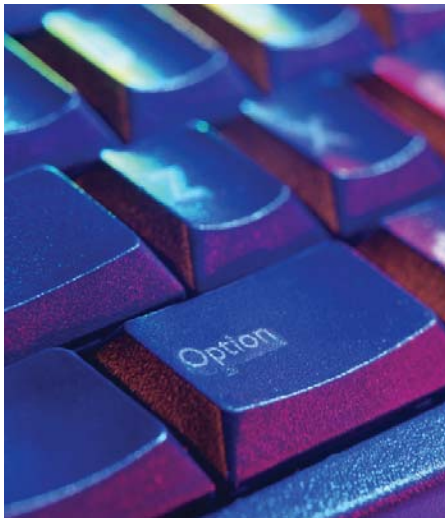
Ph.D. admissions committees expect undergraduates to spend some of their time conducting research in the summers. Hundreds of research programs are available at off-site institutions including universities, graduate schools, government institutions, industrial or engineering settings.

Summer programs are often paid positions, and sometimes offer a combination of research-related seminars, discussion groups, skills workshops, test preparation classes, and organized social activities

Applying to Summer Research Programs:

1. Get information on a variety of programs, including programs in settings where you might apply to graduate school. Resources you might consult are professors, academic advisors, peers and websites like the following:

   http://www.aamc.org/members/great
   http://www.ASCB.org
   http://www.NSF.gov
   http://www.SACNAS.org
   http://www.yale.edu/necuse/



2. Create a spread sheet with information about programs. Match yourself to programs, depending on your research/work interests, type of program, activities offered and the location. The differences in money offered will not matter over time. Chose programs based on how they meet your needs.
3. Submit all materials (often includes transcripts, letters of recommendation, skills evaluations, essays) before the deadline. If it is impossible to submit information before the deadline, email the program director, explain the situation and request a late submission.
4. Emphasize your research interests, experience, and intellectual involvement, not community service or club involvement. If you have had relevant research/work experience, describe it effectively (see Chapter 14, "Describing Research Experience"). Some programs may ask you to discuss your research interests. Read about areas in which you are interested and let the reviewer know you have some familiarity with specific topics. Write more than a couple of sentences.
5. Follow-up to be sure all your materials arrived. Email is usually the best way to communicate with program staff, who are more likely than the director to know if your file is complete.

Communicating with Program Directors:

Research program directors are busy people, but they are interested in you and are typically willing to help you with issues that require their expertise. How can you optimize your interaction with a program director?

1. Focus your inquiries on important issues. Explain situations or ask questions concisely. Email communication is useful for questions that don't involve extremely complex situations. Some very personal issues might be better handled by phone.
2. Don't ask the director questions that are obvious from the website or program brochures. They will appreciate it if you do your "homework" and contact them with questions that do require their input.
3. Some programs require an interview of everyone. Summer program acceptances are usually based on a written application, with perhaps some phone contact. Barging or deceiving your way into see or talk with a program director just because you think that having personal contact will enhance your acceptance usually backfires. In a sense you are saying the application process isn't fair if your personal visit gains you an advantage.
4. Listen to program staff. Don't ask three people, including the director, the same question, because you don't like the answer you are getting.
5. Provide requested information.
6. Recognize that directors will have different amounts of time to "chat" with you depending on their other obligations. But, talking and listening to students is an important part of developing and conducting excellent programs. College and life has changed since we were students, so we need your insight. Every student is different, so we need to get to know you to help guide you toward the most successful career outcome.
7. Be proactive. When possible, address problems before they reach crisis level. People become research program directors because they like students and want to help them. One of their roles is to help you deal with problems, but they can't help you if you won't communicate.

Choosing a Project/Lab:

Consider things like:

-What type of research/engineering interests you?
-What are you prepared to do?
-What techniques/procedures would you like to learn more about?
-What are your long term goals?
-How does your personality fit the lab/work atmosphere?

Expectations of Research Program Participants:

1. You should prepare to succeed before coming to the program/starting work. Contact your assigned mentor and read background material on the project, if possible.
2. You should perform to the best of your ability.
3. Ask questions and be sure you understand what is asked of you. Take notes and pay attention to them!
4. You should leave all information (lab-notebooks, notes) and reagents in the lab.
5. You should complete the program in its entirety.
6. You may be required to give a short presentation or write a short paper or abstract describing your work during the program. This gives you a chance to demonstrate what you have learned, how you have contributed to the project and the direction future research might be headed, both within your project and beyond. You should be thinking about preparing summaries throughout your experience and be sure and leave enough time to write and practice your presentation. For tips on writing abstracts and making presentations, see Chapters 9, 11 and 12.
7. Complete program evaluations. You should update the program on your research progress throughout your career. Programs are often financed by donors who need to assess the benefit of providing real life work experiences for undergraduates. Even if you change your career course, it is helpful if you identify whether/how the program affected your education and career progress.

Making the Most of Your Research Experience:

1. Work with the program director regarding lab/job placement.
2. Check out faculty/projects and provide requests to work in several labs or areas.
3. Recognize that not every student gets her/his preferred choice. Often the most experienced students will get their first choice. Take advantage of the situation you are offered to build your knowledge and skills, so you will be prepared to be placed in your first choice position in the future.
4. Don't accept a position if you can't make a commitment to give it your best effort.
5. Keep all correspondence with your program and contact your mentor before you start on how you can prepare to be as successful as possible.
6. Read background material on your project and try to read any papers the lab/group has published. Even if you don't understand everything, you will gain some knowledge.
7. Learn how to work with your mentor(s) by referring to the hints on Making the Most of Mentor Relationships in chapter four. Communicate with your mentor and program director often.
8. Pay attention during training, ask questions and take notes.
9. Keep good records of your work: lab notebooks, notes, journals.
10. Budget time well and use it wisely. Internships are usually very short term. Use "wait" time to update your records, read papers, or plan experiments/work.
11. Plan and organize your research and extracurricular activities and take advantage of what is offered to you.
12. Be a team player, respect others, recognize their contributions to the project.

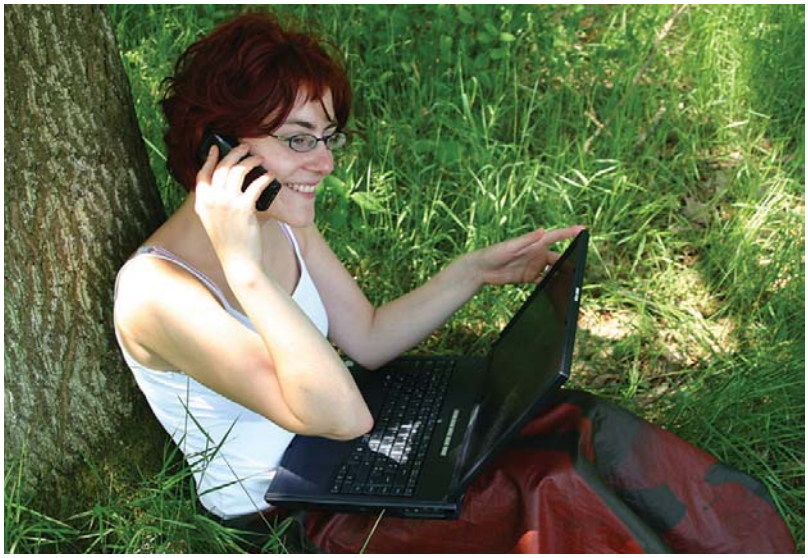
Finalizing Your Work:

1. Be sure you understand both the short-term and long term goals of the project.
2. Summarize your work in written and oral forms, including overall goals, your goals, your work, the results and its implications. This will be helpful when you apply to graduate school or for a job.
3. Leave information and reagents in good order.
4. Ask about letters of recommendation. Can the mentor write you a positive letter?

5. Recognize that you are learning how to do research/work, and that while you are contributing to the project, you may not contribute enough to be an author on posters or papers.

Capitalizing on Your Research/Work Experience

1. Keep a file on each research/work experience with a copy of your application and a summary of what you did and learned (use the abstract you wrote).
2. Use what you learned through the internships in class, in discussions with faculty, future research/work experiences, for graduate school applications.
3. Maintain contact with program directors, mentors/employers, co-workers, program participants. (Parents love email or unlimited phone minutes!)



Summer Research Then and Now

Summer research has changed as much in the last 30 years as the difference between using a slide rule and today's computers to solve math problems. I never heard of a summer research program for college students when I was an undergrad. I participated in a NSF sponsored summer program for high school students, but only because they bent the rules and let me participate in a program in my hometown and even let me live at home. You had to pay travel and housing expenses to participate in the programs and my family couldn't do that. Paying family medical expenses didn't leave much to fund expensive educational experiences. But I got a "break". I guess we'll never know how much that experience influenced my interest in science.

College research experiences were available to me. Because of my previous science fair experience, the Chair of the Chemistry Department met with me the first day of college and talked to me about undergraduate research opportunities. Unlike a lot of people in the 1970s who didn't think girls could be successful at chemistry, Dr. Larry Spears was very encouraging regarding my career interests. I majored in chemistry because I was really interested in biochemistry. There was one biochemist at a time in our department, so that's who I worked with starting the summer after my freshman year. I would take one class each summer and spend the rest of the time in the lab, isolating enzymes, and accumulating so many research credits that they finally stopped counting them. Dr. Rhoades left for another position and the department hired another biochemist – another enzymologist, so I switched enzymes, but not cold room locations. I didn't have much guidance. There were no seminars or journal clubs, few discussions of data or procedures, but I was acting like a real scientist and I loved it! I'll never forget the night I was standing at the spectrophotometer and watched my substrate turn from colorless to bright orange before I could close the lid on the spec. I thought I'd made a mistake in the substrate solution, so I remade it. But, when I had to dilute the enzyme prep 1000 fold to get a change in OD that wasn't so fast I couldn't measure it, I called Dr. Danner – at home. He rode his bike to the lab at 10 pm– dressed in PJs or maybe they were sweat pants and a gym jacket! I had made changes in starting material that uncovered a new isozyme with higher activity per gram of thymus gland and different kinetic properties.

I found out how many things I hadn't done in the best way when I started grad school – but my time in the lab taught me to jump in and get things done, fueled my interest in research and left me realizing how much I could have learned from a program like the SMART Program (http://www.bcm.edu/smart) that I would develop 15 years later.